THE

BOTANICAL GAZETTE

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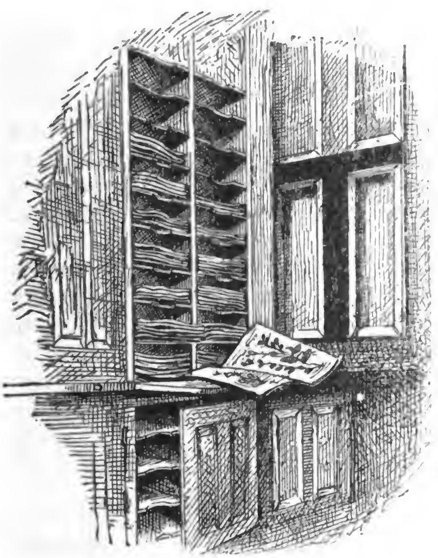
Botany in the University of Pennsylvania.

(WITH PLATES I-V.)

The year 1860 saw the United States without a single botanical laboratory. It is true that in Philadelphia there was the herbarium of the Philadelphia Academy of Natural Sciences, and that in New York City the Torrey herbarium stood open to all properly accredited students; and also in Cambridge the greatest of all American herbaria and greatest of all our systematists and best of men, Asa Gray, welcomed students who came with serious intentions. But there was nothing corresponding to the laboratories of the old world, where the whole science of botany could be studied under thoroughly trained men.


CORNER OF THE HERBARIUM.

Twenty-five years later, the condition of affairs had so changed that we had a number of fairly appointed laboratories. In earlier times, if one desired to become proficient in tracing the life histories of the lower forms of plant-life, if he wished to follow the development and evolution of tissues, or to study vegetable physiology, there was nothing for him to do save to go abroad. Such a condition of affairs, in a country whose growth and material prosperity was the marvel of the century, was not only lamentable, but it was disgraceful.

We now have not only laboratories, but we have American students, trained abroad, to direct them. One thing yet we lack. It is the full recognition of the fact that the highest function of a laboratory is to increase knowledge, and that to do this the professors should have ample time and be

relieved of most of the drudgery of teaching. This, however, is only a question of a few years; for in nothing desirable can this country afford to suffer by comparison.

The latest laboratory we illustrate in this number. It is that of the University of Pennsylvania. This is the outgrowth of a long series of very slow steps. In the early part of this century, Doctor William P. C. Barton, surgeon in the United States navy, was made professor of botany. Though he was a zealous man, and, for the times, well fitted for his work, he left almost no impress upon the teaching of the institution in botany. We can hardly think the failure is attributable to him.

In the year 1865, the late distinguished George B. Wood, with a liberality as rare as it was praiseworthy, partially endowed, under the title of the Auxiliary Faculty of Medicine, five chairs. Among these was one of botany. It is true that neither the salary nor the duties of the incumbent were very large. His pay never, under the endowment, exceeded five hundred dollars a year, nor was he expected to do more than deliver thirty-five lectures for that sum. It is true, all that the professor of botany did beyond this was fully appreciated by the authorities, but it can hardly be said to have opened any avenue for promotion, because no avenue was possible under the circumstances.

The first professor of botany under this endowment was Horatio C. Wood, M. D., who was then distinguishing himself as a pioneer fresh-water algologist, and who afterwards won even higher honors in the field of materia medica and therapeutics.

Professor Wood resigned his position in 1876, and Dr. J. T. Rothrock was, on the suggestion of Professor Asa Gray, chosen to succeed him. The liberality of the late Eli K. Price made it possible to obtain some dissecting microscopes and to open a laboratory for analytical work. Beyond this nothing could be accomplished, until the year 1881, when the University, recognizing, at last, the need of more extended botanical instruction, established a full chair of botany, and undertook to provide a course of instruction preparatory to medical study. The idea was a good one, but there were insuperable difficulties in the way of its largest success.

In 1883, the accident of two ladies (one coming from China) desiring to study the natural sciences in Philadelphia, and finding in that great city of a million inhabitants no place where they could receive regular instruction, opened the

eyes of the community to its educational shortcomings. Funds were at once raised for a Biological school under the auspices of the University of Pennsylvania, in which the same privileges were to be accorded to both sexes. This was the very foundation-stone, the leading principle, out of which the new movement took final shape. It should also be added, it was fortunate that Prof. Horace Jayne, M. D., was made secretary. But for the gift of his time, his executive ability and his money, the fullness of hope might have been long deferred.

Plate I gives a northern view of a three-story brick building, 82 x 47 feet. A glance will show that, though nothing has been wasted upon mere architectural effect, the more important consideration of light for work has been fully considered. We may also add that upon its heating arrangement and water supply great attention has been bestowed.

Plate II shows the interior of the laboratory of general biology, seen from the east. This room, capable of seating fifty students comfortably, and providing for all the appliances of work, is now regularly filled with an attentive and promising class derived from the biological and veterinary schools; from the college and from the auxiliary medical course. The same room is used for general biology and for botany. In other words, it is the work-shop of the first-year students. The advantage of this plan is that each student can thus receive a simple and a compound microscope, a full set of staining and micro-chemical reagents, and be held strictly responsible for them. Each man has exclusively the key to a safe-lock closet. On entering, he deposits a moderate sum to cover breakage, etc. After deducting his indebtedness, the remainder is returned to him at the end of the season.

The long gas-pipe seen overhead and the jets along the front wall supply to each worker means of applying heat or receiving light as he may require.

In the first term of the first year the entire class attends the laboratory instruction of Prof. W. P. Wilson on the gross anatomy of plants, and later on receives lectures upon the elements of vegetable physiology from the same gentleman. He also gives instruction upon describing plants.

In the second term of the first year the students have instruction from Prof. J. T. Rothrock in analysis of our common plants. This work is, by choice, on dried plants. The systematist in botany will always be obliged to do much of

his labor from similar material, and it is well worth the while of the student to learn how it is done.

The botany of the first term of the second year is histological and physiological. For this class a special laboratory is provided, adjoining the room where the general work of the second year is done. Plate III shows, unfortunately, but a corner of the physiological laboratory. Here one finds abundance of aquaria, large and small, the usual supply of tubing, test-tubes, air-pumps, etc. In fact, the desire is to furnish whatever is needed for working out the usual problems of this stage of botanical study. Prof. Wilson has arranged a very satisfactory course of practical instruction in this direction.

The physiological laboratory communicates also with the greenhouse (Plate IV), in which abundance of fresh material is found.

The second term of the second year brings the student to Prof. Rothrock for some of the practical aspects of botany. He may decide for himself what direction his study shall take. Most of the students prefer medical botany, as it is directly in the line of the profession into which the vast majority of them ultimately go. Or the opportunity is given for close study of different kinds of work, or the student may prefer *general economic* botany.

There are beside special rooms provided for these advanced students who are capable of doing original work.

Miss Emily L. Gregory, who is so well known to the readers of the GAZETTE, is now engaged in pursuing her investigations in this building. Plate V shows one of these laboratories for special workers.

In the building there is a very complete local herbarium, the gift of Mr. Isaac Burk. The herbarium owned by Prof. Rothrock is here and available for purposes of study. It has a value from the large number of the type specimens of our western species which it contains. Among them are found sets of the collections made by the earlier government explorations west of the Mississippi. Also those of Bolander, Parry, Hall and Harbour, Lemmon, Palmer, Rothrock and Pringle. The small illustration heading this article shows a corner in the herbarium.

The student also has access, under proper restrictions, to the facilities for study offered by the Philadelphia Academy of Natural Sciences. The library and herbarium of that institution are among the most valuable in the country.

The botanical garden is now fairly started, and already

adds very considerably to the teaching resources of the institution. Steps are being taken for its immediate enlargement.

The advances made in the recent past by the photographic art suggested that the biological school should not only have a place provided where it could take advantage of the help there afforded in illustration, but where photography, as applied to scientific work, could be taught.

During the past season the results in this direction have amply confirmed the opinion as to the value of photography in botany, both for reproducing microscopic appearances and for the larger visions of field work.

Development of cork-wings on certain trees. IV.

EMILY L. GREGORY.

Physiology.

The question of function can only be raised here, in case this peculiarity of structure is sufficiently emphatic to render it probable that some special object is to be gained from it. Assuming this to be true, the difference in the morphology of the three kinds described suggests a corresponding difference in function. In connection with this, two important principles held by scientists of the present day are to be considered. First, that no peculiarity of structure in living organisms is supposed to exist without adequate cause. For example, the wings of Euonymus alatus, which appear to the ordinary observer as useless if not cumbersome appendages, may be accounted for as a result of an effort on the part of its ancestors to accommodate themselves to their environment. According to this, it is not necessary, however, to show that an organ which proved advantageous to the ancestors of this plant is of equal service now to the offspring, unless it can be shown that the circumstances which called it into existence are still unchanged.

The second principle is that nature is extremely sparing of material; that of all the various means made use of to attain an end, those requiring the least outlay of material are the ones retained, and peculiarities of structure arising in harmony with this principle are the ones transmitted by inheritance.

Assuming the validity of these two principles, it would seem a proper question to ask: Of what use to these plants

are these corky outgrowths, and is the advantage secured commensurate with the outlay of the material? It is not claimed, however, that the results of the present investigations are such as to render possible a satisfactory answer to these questions. It is hoped that the few thoughts which have suggested themselves in this connection may be of some slight value.

The earlier researches made on the subject of cork seem to have fixed its use in the plant economy, as that of protection, mainly in the way of a substitute for epidermal tissue. This certainly is the office of periderm, both superficial and internal. Later investigations have somewhat broadened the meaning of the word; cork tissue has been defined,[1] "Not simply the tissue produced by cork cambium, but all parenchymatic cells which produce resin and which have a corky membrane, in general every cell which has a corky membrane." Accepting this definition, we must include as part of its function the repairing of tissues torn or broken by external or internal causes and aiding in the regulation of gases and transpiration.

We have already referred to Höhnel's division into phelloid and real cork-cells; to the former he gives two functions—first, to separate the bark from the stem, "Trennungsphelloid;" second, to take the place of the real cork, "Ersatz-phelloid." According to the strict definition of bark, the first function can not be ascribed to the phelloid of the wing, nor, in fact, to that of any found in the superficial periderm. The second function means nothing unless we are able to decide what use the real cork would be to the stem if occurring in the same place.

Sections of the various kinds of wings were subjected to the usual tests for suberin, with varying results in the same species and sometimes even in sections cut from different places in the same plant.

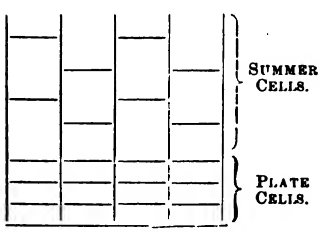
Sections of Liquidambar thoroughly heated in Schulze's macerating fluid and then treated with chlor-iodide of zinc, showed the following results: In no single case did all the summer cells show the pure ligneous reaction. The walls of some of these cells contained more or less suberin. In three or four experiments in which a large number of specimens were treated, the greater number of these cells were ligneous. Especially was this the case with the early summer cells of each year. This indicates that these cells are not lignified, if at all, until they reach some distance from the phellogen layer. The plate cells always showed the

[1] By E. Adlerz. See abstract in Just's Jahresbericht, XI (1883). 525.

suberin reaction. Several cases showed no inclination to the ligneous reaction; summer, as well as plate cells, appearing to be true cork, except along the edges where the break occurred. All along these edges the walls of the exposed cells and those lying next to them were colored a bluish purple, the color diminishing gradually in intensity toward the central portion of the wing. This is a noticeable and significant fact. In almost every specimen tested the outer edges were not suberized. This was not due to careless testing, as might be supposed, only enough of the chlor-iodide of zinc being used to affect the edges, for the sections were treated freely with this without a cover glass, and the reagent was dropped carefully on the center of the wing before it was allowed to reach the edges. The summing up of five or six sets of experiments is as follows: the tendency is for the summer growth to form ligneous walls, plate cells always cork.

In Quercus the results were very similar. A few specimens showed no ligneous tissue, several only at the edges along the lines of fracture, and still others gave a pure ligneous reaction throughout the entire summer cork. The same may be said of Acer campestre.

In Acer monspessulanum the results were the same, except here there were always ligneous cells along the line of breakage. Euonymus alatus differed from the preceding only in that the tendency to ligneous cells in the summer growth was more marked. A few words in passing here with reference to the morphology of these cells. In all examples studied, in case of the summer cells, the radial walls were met by the tangential ones about in the center of the cell, while in the plate cells the tangential walls were so cut off from each phellogen cell as to meet each other, thus forming a continuous line around the circumference. (See diagram.) This construction of the summer cells is mentioned by Gerber[2] in reference to the outer cork layers of certain trees, which layers are stretched by the growth of the wood and phloem tissues inside. In the case he cites, this construction is accounted for on the ground of its allowing this stretching in the direction of the circumference, the radial walls bending so as to form a zigzag line when looked at from a



²A Gerber. Die jahrliche Korkbildung im Oberflächenperiderm einige Bäume. Sitz. bericht der Naturf. Ges. zu Halle, Jan. 12, 1888.

cross-section. This line, according to Gerber, indicates the degree of tension produced by the pressure of the new cells growing within the zone of cork cells. Now, the significant fact in connection with this in the cork wing is, there is no such tension from pressure of the growth within, because the constant breaking of tissue from the outside prevents it. The cells, which are arranged for this purpose, keep their rectangular form. The plate cells of the fall growth, which form a connected zone about the stem in Quercus and Acer and in Liquidambar connect with the regular periderm of the rest of the stem, have not this contrivance for stretching, and it may be supposed are more easily broken by the pressure within when the sudden and vigorous growth of spring begins. On the other hand, it was found that in the majority of specimens the walls of the plate cells were decidedly thicker than those of the summer cells, and in nearly all cases both radial and tangential walls were bent and curved.

In the formation of the wings of Quercus and Acer and others of a similar type, the first steps in the process are easily explained on the score of purely physical causes. The breaking of the tissues is the result of the strain, greater here than in other places, on the fresh yielding tissues. The increased rapidity of growth following this breakage is not unlike that caused by a wound external. Very soon, however, in Acer there is a change in the place of growth; that portion exposed by breakage to the more free action of the air is soon built out, so that many layers of cells occur between the phellogen and the external portion. (See *a* in fig. 3.) No reason suggests itself for the change in the place of rapid growing to the center of the wing, except the one which may be used when all others fail, namely, inherited tendency in this species. With Quercus this change of base in growth either does not occur or is much more gradual. As to the question of possible or probable advantage to the plant in these two examples, a few words on the function of lenticels are necessary.

In general they are held to be to the superficial periderm what the stomata are to the epidermis. Notwithstanding the thorough investigations made of these organs at different times, there still appears to be some question in regard to their exact mode of action in all cases where they occur.

Haberlandt[3] says that in case of green stems without per-

[3] G. Haberlandt, Beiträge zur Kenntniss der Lenticellen. Sitz. berichte der k. Akad der Wiss. in Wien. Bd. 72. 1875.

iderm, when lenticels occur, they serve to hinder transpiration, on stems with periderm they increase it. Zahlbruckner[4] says, in winter they are permeable for air only in slight degree, in spring they are fully open, that is, in a condition to allow exchange of gases freely before the leaves have reached their growth. Klebahn[5] says, a winter closing of the lenticels does not exist, and that their permeability for gases in certain plants is the same both in summer and winter, in others, greater in the early part of summer.

One glance at the anatomy of the wing of Quercus macrocarpa and of Acer will suggest the possible connection here. The lenticels are raised by the rapidly-growing wings until they are separated entirely from the cells within the phellogen layer which they are supposed to furnish with air. Finally the outer cells break in regular lines along the corners of the stem, and during the first year, all along these broken places, free communication between the phellogen cells and the outer air is hindered only by the thin cellulose walls of one or two layers of cells. We say cellulose; we have proven that these walls are in no case suberized; they may be slightly lignified, but even in this case would offer less resistance to the interchange of gases than the suberized upper wall of the epidermis.

We then have the furrow between the wings acting as a continuous lenticel, in a less degree permeable, but still rendering an interchange of gases possible. Now as winter approaches this furrow is closed, in every case, by a few layers of real cork cells whose walls are suberized. In the spring this zone of cells is broken, the same conditions are renewed as in the preceding summer, as regards interchange of gases.

The probability that these furrows serve the plant in this way is increased in the case of Quercus by comparing its superficial periderm with that of Quercus suber. In the latter, the presence of the large and numerous lenticels, extending from the phellogen layer nearly to the surface of the thick periderm, and communicating there with the external air by means of shallow cracks along the surface, shows conclusively that the inner portions of the stem need to be in communication with the outside air. These lenticels are entirely wanting on the stems of Quercus macrocarpa. De Bary[6] states that lenticels lie in the furrows of the wings of Acer campestre, Euonymus Europæus, Ulmus and Liquid-

[4]Abstract in Just's Jahresb. XII. (1884) part 1, p. 265.

[5]H. Klebahn. Jenaische Zeitschrift für Naturwissenschaft, 1884, p. 588.

[6]Anatomy of Phanerogams and Ferns, p. 562.

ambar. This passage is given in explaining a sort of converse to the usual form of lenticels, that is, convex externally.

I have been unable to harmonize this statement with the examinations made. In no stems of Acer campestre under three years of age were any lenticels discovered between the wings; in fact, the anatomy given of the first and second year's growth seems to preclude the idea of lenticels forming in this position. If occurring in this place, in any of the stems available for examination, it must have been on stems so far advanced in age as to have lost the peculiar winged appearance. Such stems were not examined. It is still more difficult to understand the meaning of this passage in case of Liquidambar and Euonymus Europæus. There is here no question about the position of the lenticels. As already explained in the anatomy, the wings of Liquidambar occur, at first, as a single ridge, under a row of lenticels on the upper side of the stem, which afterward splits open along the line of opening of the lenticels, in many cases the break extending quite to the phellogen cells. During this growth there is a large portion of the circumference of the stem not affected by the wing formation; over this are scattered the convex lenticels, which are in no way different from those on stems without cork. None were discovered between the wings in any other sense than this, and there are certainly no exceptions to the usual convex lenticels.

In Euonymus Europæus, the wings are at the corners of the stem, and between them are broad spaces covered with epidermis, which is plentifully supplied with stomata. These soon pass from that stage into that of corky excrescences, which, examined after they are considerably developed, appear to consist of the same tissues as the wing.

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The "King-Devil."

LESTER F. WARD.

On the 24th of August, 1879, as I was returning from a hunting excursion of two weeks in the "North Woods" which flank the Adirondack mountains on the west (my own game having been entirely of a vegetable nature), to Evans'

Mills, in Jefferson county, New York, where the party was fitted out, we passed through the little town of Carthage, and before having fairly left the town I espied from the wagon an unfamiliar weed growing by the roadside. Leaping from the wagon, as I had done a hundred times before, and plunging my garden trowel under it I brought it up with a clod of earth which I shook off as I ran on and regained the wagon. I immediately recognized it as an Hieracium, but quite distinct from any of our native species, with all of which I thought I was familiar. The first glance made me very desirous of obtaining more, but a down grade with good road started the horses on a fast trot and I saw two or three specimens go by before I was able to obtain another without begging the driver to stop for the purpose and seeing him stare impatiently at me, as he, at least internally, cursed me as an incorrigible "crank." At length our speed slackened and I succeeded in obtaining one more specimen in the same manner as before.

I examined the specimens carefully, shaking my head as I placed them in my swollen portfolio, and resolved, that, if possible during my stay in that section, I would obtain more of the plant. Accordingly, on the following day, I gladly accepted the invitation of Mr. Jerry Walrath, since deceased, who was with our party, and a very pleasant gentleman, to take me a long ride around the country in the vicinity of Evans' Mills, which is chiefly noted as the site of the settlement on Pleasant creek, some three miles above that place, of the early French Le Ray family, the heirs of which preserve the estate almost like a park. I was, I confess, thinking all that day, which I remember with much pleasure, more of my new hawkweed, which I believed to be a modern immigrant from the continent, than I was of the more ancient immigrants about whom my friend so intelligently discoursed. At every fence corner and in every lane I scanned the ground, hoping to see it, until, as Thoreau says, the earnest searcher after a particular plant, the image of which has long been in his mind, will eventually do, I at last espied it, not, however, in isolated individuals growing by the barren roadside, but in a large colony, growing compactly together, the radical leaves in prostrate rosettes, forming an almost unbroken mat upon the ground along both sides of a fence that bordered a plowed field. The area was restricted, it is true, to a few rods in length, and to one side of the road, but it looked as if, prior to the last plowing of the field adjoining, it might have

extended some distance inward. The plants were smaller and slenderer than the ones I had seen at Carthage, and it was a moment before I became certain of their identity. They represented all stages of advancement, from the buds to the ripening head, and I observed the light akenes, with their feathery pappus, detaching themselves from the plants and being borne away by the wind. I distinctly remember saying to Mr. Walrath, who, as I had told him what I hoped to find and he had seen me get the Carthage specimens, manifested a genuine interest in the matter, that if the farmers of that section did not take measures to prevent it, that plant might become a great pest, a remark which, I doubt not, if he were living, he would also recall. The particular spot where I found the plant on that day was some three miles northeast of the village of Evans' Mills, on the farm of Mr. John Evans, a descendant of the early family who gave their name to that place.

I took a goodly number of specimens and brought them back with me to Washington, where, at the herbarium of the Department of Agriculture, I carefully compared them with all the species of Hieracium there represented, and concluded that they agreed better with *H. fallax* Willd. and *H. præaltum* Vill. than with anything else I could find. I sent specimens both of the Carthage and the Evans' Mills collections to Dr. Gray, stating some of the circumstances, and writing on the labels the names of the two species that I thought lay nearest to my plant. I am unable to recall the exact nature of his reply, but I am certain that it was not final and that he desired time to investigate the subject. Getting no further word from him, I distributed most of the specimens under the name "*H. fallax* Willd."[1] When Part I of Vol. II of Gray's Synoptical Flora appeared, my attention was called to the credit given me on page 424 for the discovery of the plant in this country. It is, as he cautiously remarks, "a form" of H. præaltum, and I shall presently note the principal points of divergence from the type of that species.

As is the habit of romance writers, I must now ask the reader to figure to himself the lapse of a considerable length of time, viz., eight years. After the smoke of the great bat-

[1] I wish to say here that, through some curious inadvertence, I now possess neither of the specimens collected at Carthage, and to ask any of my old correspondents to whom I sent the plant (the Harvard Herbarium excepted), who may chance to read these lines to take the trouble to look and see if his specimen is labeled from that place, and let me know if it is, as I would be glad to know where these specimens are.

tle, which was called the Cleveland meeting of the American Association for the Advancement of Science, was over, I retired, begrimed and discomfited, to the classic banks of the St. Lawrence, where the winds, though sometimes brisk, are not laden with carbon, and where some members of my household had gone before me. The night of my arrival I heard through them that a botanist from Albany had recently visited Evans' Mills and Carthage in search of a plant that he said I had found there, that he had called on Mr. William Comstock, an intimate friend of mine, and who had been the life of the hunting party above alluded to, and questioned him concerning it. I immediately had my suspicions as to what plant it was, which were fully confirmed a few days later when Mr. Comstock and his wife came from their home in Evans' Mills and spent a day with us at the Central Park. I learned from them that the gentleman's name was Peck, and I at once knew that it could be none other than Prof. Charles H. Peck, State Botanist of New York. Mr. Comstock related to me the interview with Mr. Peck as nearly as he could remember it; that he was in search of a plant that I had once collected at Evans' Mills and Carthage, that the plant was a "hawkweed," etc. Mr. Comstock said he told him that there was a hawkweed growing there on all the farms which was a terrible pest to the country and had gained the name of Devil-weed, King of Devils, or, more briefly, the King-Devil, but that this could not be the rare plant he was in search of, because it was so extremely abundant, and, besides, it flowered in June, and I had collected my specimens late in August. He further said that, unable to find the plant at that place, Prof. Peck had secured a conveyance to Carthage, and that he understood from the party who drove him there that he also failed to find it there.

The narrative interested me intensely, and I did not hesitate long in accepting the invitation of my friend, Mr. Comstock, to come and spend a little time at Evans' Mills, and to go about the country again. To be brief, I spent the most of two days (September 5 and 6, 1888) almost exclusively in the investigation of this question. One hour after arriving there I satisfied myself that the King-Devil was none other than Hieracium præaltum, which, as I had predicted, had been sown broadcast by the wind over that entire section of the state, and had now become a veritable terror to the farmers. We traveled over much of the worst infested region and found no one who did not know perfectly well what

the King-Devil was. It forms a continuous mat of pale green leaves lying flat on the ground and preventing any other form of vegetation from taking root. In June it sends up a scape, or, more properly, an almost leafless, more or less branching stem, bearing a large number of flowers in a panicle, which quickly ripen and permit the achenia to be scattered by the wind. The stems then die and turn brown, but persist in an erect position, the leaves at the base remaining green, thickening and multiplying and the plants spreading by suckers as well as by seed. This last I proved by securing specimens with two distinct plants attached by the subterranean rhizome.

Notwithstanding this date of normal flowering, I was not disappointed in my attempts to procure good specimens. As the inhabitants well know, the King-Devil sometimes yields two crops of seed. By this is meant that fresh flowering stems will occasionally spring up in late summer, apparently always from plants that did not fruit early in the season. But, as far as my observation went, this was sporadic and comparatively rare. In fields infested with the plant it was difficult to find such autumnal bloomers, but they occur in considerable numbers standing more or less isolated along the roadsides and at other places where there is little or no vegetation. In this condition they could be found at the time I was there, growing very large and thrifty, in all stages from early budding to mature fruiting. My undue zeal led me to collect a very large number of fine specimens, and this is perhaps the place to say that these specimens are for free distribution to any that may desire them.

I made careful inquiries, first, as to the local origin of this noxious weed; secondly, as to the date of its first appearance; and thirdly, as to the exact extent of its present distribution.

To the first of these inquiries I received the almost unanimous answer that it was first seen on the farm of Mr. John Evans, and that from this point it had spread only in an easterly or southerly direction, owing to the prevalence at the time it is in fruit of westerly or northerly winds. As to the second inquiry, while I found those who stated that it had been known near this point of origin for fifteen or twenty years, the consensus of opinion seemed to be that it had not been regarded as a pest for more than seven or eight years. This last is certainly true, for had there been any such noxious plant in that vicinity in 1879 I should have heard of it,

and had it been known then as it is now, I should have been derided for getting off a wagon to dig a specimen of the King-Devil. May it not be that, after a day's search, I found it on that occasion at or near the very nest in which it was first hatched in the United States? I revisited that spot and found it still holding its own, but it had then spread in all directions, and could be found in every lane and by every fence in all that section of Le Ray township.

With regard to its present distribution I could obtain much less satisfactory information. I was told that it had swept a tract of country from five to ten miles wide, but as to the length of this belt no one was able to give any definite idea. Carthage would be immediately in its track, but this is only a distance of fifteen miles. Finally, not having investigated other parts of the state, I am not, of course, prepared to say whether this is really its center of distribution, or whether it may not be equally destructive to other sections, but I incline to believe that such is not the case. It is one of the legitimate questions for the state botanist to investigate, and whenever he shall do so I shall be very glad to learn the result. I am certain that it does not occur among the Thousand Islands or along the St. Lawrence river adjacent, having just spent ten days in studying the botany of that section, with my attention specially drawn to the subject; but the nature of the country here is such that it would scarcely be expected to grow, even if introduced. I met a young man named F. W. Barnes, who resides at Auburn, and who told me that a similar plant, but with purple flowers, was found in that vicinity. At my request, he has sent me a specimen since my return to Washington, which proves to be *H. aurantiacum* L., thus showing the accuracy and clear discrimination of Mr. Barnes, to whom I desire here to express my thanks publicly, as I have already done privately. I have since corresponded further with Mr. Barnes, and he informs me that he knew of this plant only in one place near Auburn, where, as the owner of the land informed him, it had been known for twelve or thirteen years without tending to spread, because it had been prevented from going to seed. He understands that plowing it under kills it. He says that he has never seen the King-Devil in that section of the state, but that he once saw it at Napanee, Ontario, thirty-five miles west of Kingston. If there is no mistake in this last observation, it is a very important fact, and will require us to look still farther westward for the first starting point of our un-

welcome immigrant. May it not have been originally a ballast plant of some Canadian port, as Toronto, for example?

Another question to which I gave some attention was that of how this modern intruder can be destroyed or expelled. About the only remedy that had been tried was that of salting the places infested with it. This, if thoroughly done, kills the plant, but it also kills everything else. It is expensive, and can only be successfully practiced in cases where the plant is still confined to comparatively small spots. If taken in time it can be temporarily kept from a given territory in this way. Its habit is to spread by small colonies, which, if left undisturbed, will eventually become confluent and cover entire fields. A single seed would probably produce one of these colonies in a few years, the original seedling propagating by underground stolons through a succession of generations, and thus working out radially in all directions. I visited the portion of Mr. J. P. Steinhilber's farm, where salting had been practiced some months previous, and saw that it had for the time being destroyed all vegetation, but, singularly enough, I found growing in the middle of the area thus blasted several large autumnal specimens of the King-Devil in fine condition for the botanist, two of which I collected and have specially labeled. No other vegetation whatever had sprung up on this sterilized soil. Mr. Wayne Stewart, whom I was unable to meet personally, has conducted the experiment of salting on a large scale, and is said to regard it as a success. After having been destroyed in this way the plant will not reappear until again seeded by the wind from other parts.

The only other remedy I heard of was simply to plow the plants under, when a crop may be raised upon the ground thus plowed, and many of the roots will be killed. The subject should certainly be investigated scientifically at the State Experimental Station and means devised, if possible, to prevent the further spread of so dangerous an enemy of the agricultural industry of the state of New York.

The species *Hieracium præaltum* was originally named by Dominique Villars in F. C. Gochnat's Tentamen medico-botanicum de plantis Cichoraceis, 1808. De Candolle, in the Prodromus, enumerates five varieties, but he treats *H. fallax* Willd., with its three varieties, as a distinct species. These are now generally regarded as simply varieties of *H. præaltum*, having the leaves somewhat narrower and acute, more or less white-tomentose beneath and the stem sparing-

ly pilose. Some of the varieties occasionally bear stolons above ground, but this is never the case with the New York form, although, as already remarked, subterranean suckers are common. With the exception of the white-tomentose under surface, my specimens would perhaps fall more nearly under the section *fallax*, but in the absence of this character I am disposed to refer them to some of the original varieties of De Candolle, although this is somewhat difficult. The variety *hispidulum* of Froelich is much the nearest, this having the base of the scape and also the leaves pilose-hispid. In our plant there are frequently, but not always, strong and very long white hairs on both surfaces of the leaves as well as along their margins, but those on the scape are very few and mostly near the base; they are also quite short. The whole plant, except the dark glandular hairy involucre and pedicels, is light green or glaucescent. There are usually two small leaves on the stem, the upper of which, however, subtends the lowest branch, and the other branches are provided with smaller bracts. A minute black ring or speck encircles the base of each hair, and many such occur where the hairs are no longer present.

In the investigation of this plant and the numerous interesting questions arising from its singular advent and diffusion in that section of northern New York, I have been greatly aided by Mr. William Comstock, without whose coöperation I could have accomplished little or nothing, and also by Messrs. Henry L. Lawton and J. P. Steinhilber,[2] who gave me much practical information, and I desire, in closing, to acknowledge the services of these gentlemen.

National Museum, Washington, D. C.

BRIEFER ARTICLES.

Another death from eating Cicuta maculata.—Hon. Eugene Secor, of Forest City, this state, a member of the board of trustees of the Iowa Agricultural College, brought me to-day a fleshy root of a plant of the Water Hemlock (*Cicuta maculata* L.). The circumstances which brought it to his notice were as follows: A neighbor of his, by the name of Mr. Oleson,

[2]Mr. Steinhilber brought me two other plants which he said were becoming quite troublesome. The one was *Potentilla argentea* L., which I had seen abundant in the fields. The other was *Poterium Sanguisorba* L., which I had not seen, but which must have been introduced quite extensively into this country, as I found it in 1883 at Odenton, Md., and it has been found at Baltimore and at several points in New York state. I also have it from Mr. Martindale as a Philadelphia ballast plant.

a farmer about fifty years of age, while dragging some potato ground upon bottom land, about two weeks ago, discovered one of the fleshy roots of this plant, and supposing it to be an artichoke, ate of it and gave a portion to each of his two sons. He soon began to feel queer, or "funny," as he expressed it, and went to the house, where he was taken with a spasm, followed by two or three others, when he became unconscious, and within an hour, before a physician could be summoned from the village, two miles distant, he was dead. The children had probably eaten less of the root, and, being given an emetic, recovered. The plant is very common in the state, and the roots are so pleasant to the taste as to make it particularly dangerous. I may add that I ate a piece of the root of the size of a filbert with little or no unpleasant effect.—A. A. CROZIER, *Ames, Iowa.*

Floral eccentricities.—The artificial conditions which attend the growth of many cultivated plants sometimes induce very erratic development, especially in the organs of reproduction. These irregularities often persist in certain species and varieties, and may be regarded as vegetable vices which no human management can overcome. As an example, we may take the well-known habit of one of our common but beautiful June roses of sending out a cluster of buds from the center of its blossoms, and in rare cases to repeat the malformation in the secondary series.

Among the floral peculiarities that attracted my attention during the past summer was the branching of the scape of a double white tulip This forked about midway between the bulb and flower, and each branch bore an unusually large and symmetrically double blossom.

Another oddity was to be seen in an adjoining bulb bed. A plant of Crown Imperial (Fritillaria) had been transplanted late the previous autumn, and had evidently not yet recovered from the effects of removal. The root leaves developed finely, and the flower stalk grew about twelve inches and sent out the usual terminal cluster of leaves, beneath which the blossoms were represented solely by a dense fringe of cream white stamens without floral envelopes of any sort, or any organs resembling pistils or ovaries. The anthers were unusually large and full of pollen, and the plant was for many days a unique object and excited much interest.

A rather singular case of doubling in the common Portulaca grandiflora also came to my notice. Only the self-sown, single varieties were growing in the garden, and the blossom in question was on a plant which, aside from this specimen, bore only normal blossoms. This one, however, had in its center a monopetalous corolla-like growth, the peculiarity of which lay in the fact that it was the pistil which was thus transformed, while the full complement of stamens encircled it.

I should like to inquire if it is not rather rare to find Cuscuta glomerata parasitic on plants outside of the Compositæ? During the past year I have for the first time observed it on the poke-weed. The latter was in each instance apparently much reduced in size and vigor by its unusual attendant, but the dodder seemed to find in its new host all the conditions for luxuriant growth.—MARY E. MURTFELDT, *Kirkwood, Mo.*

Another phosphorescent mushroom.—Among a few hundred species of fleshy fungi which I collected in Watauga county, N. C., in the vicinity of Blowing Rock, during the month of August, 1888, was a very common species which was markedly phosphorescent. The species was referred to Prof. A. P. Morgan, who determined it as *Agaricus* (*Clitocybe*) *illudens* Schw. I had placed a large cluster at the base of a tree in front of the hotel. At night some of the guests noticed the phosphorescent light, and amused themselves by breaking the mushroom into bits and delineating, in the dark, mammoth, hideous figures. The phosphorescence resides in the hymenium, and probably in a portion of the hymenophore directly adjacent. Very young plants were phosphorescent, though not so bright as mature ones. I made several tests, but could find no phosphorescence in the stipe or in the fleshy part of the pilus. After collecting the plant, the phosphorescence continued as long as the hymenium was moist.—GEORGE F. ATKINSON, *Columbia, S. C.*

EDITORIAL.

THE DEMAND for illustrations to accompany the articles sent to the GAZETTE for publication is steadily increasing as the papers sent increase in importance and permanent value. Illustrations are particularly desirable in anatomical articles and those describing new species. We would be glad to illustrate all papers with lithographic plates, but the cost of these in this country is so great that this is impossible unless some kind friend wishes to endow this department of the GAZETTE. (There are worse uses to which money could be put.) For financial reasons, therefore, it is necessary that we confine the majority of our illustrations to the photo-engraved plate. As there is considerable labor involved in the preparation of drawings which are sent to us for the engraver, we beg to offer a few suggestions to authors regarding the matter. By attending to these hints their labor will not be increased, our own will be sensibly diminished and the final result will be more satisfactory.

Select for your drawing paper the heaviest and best quality of linen paper, such as is used by the manufacturers of blank books for bank ledgers. This gives the best satisfaction, for, in case erasures have to be made, this will stand scratching and rubbing without allowing the ink to spread. Next to this is the best bristol board. Usually the two sides of this are different, and care should be taken to use the right side. If it is desired to use much shading, the special stipple papers supplied by photo-engravers should be used with black crayon.

Make all line drawings twice the size that it is desired for them to appear. Drawings on the special stipple paper should be one-half larger

than they are to appear. By the reduction in photographing the lines are refined and some of the too common shakiness is eliminated. If line shading is employed the lines should not be closer than 35–50 to the inch.

If you can handle a pen so as to produce a smooth, even line, procure Gillott's No. 170 or 290, or, for still finer work, Keuffel & Esser's No. 1459. The sort of ink you use is of the utmost importance. It must make a *perfectly* black line, even the thinnest. Higgins' "American Drawing" or "photo-drawing" inks give such lines. No writing ink will do this.

If not sufficiently skillful with the pen, make drawings with a hard pencil on proper paper, showing all the lines you wish to appear and of the proper relative width.

Please do not make drawings on thin, soft paper, with pale ink, and of the size they are to appear.

All articles requiring illustrations, together with the drawings and all correspondence concerning illustrations, should be addressed to Charles R. Barnes, 712 Langdon street, Madison, Wis.

OPEN LETTERS.

Another "loco" plant.

I have just had handed me by the editor of our Montana *Stock Journal* a root with leaf buds on it, sent by a ranchman from Augusta, Montana, with the declaration that it is called "loco" weed, also "rattle weed," and that it is "killing horses."

The root and plant sent me is undoubtedly *Oxytropis lagopus* Nutt., and I am astounded to hear of its ill-repute at Augusta. I am so much astounded that I think a mistake must have been made by the ranchmen of Augusta in identifying the plant that does the mischief. Have your readers any knowledge of this matter? F. D. Kelsey.

Helena, Montana.

CURRENT LITERATURE.

Saccardo's Sylloge Fungorum.[1]

The volume of the Sylloge before us covers a specially interesting part of the field. In its preparation Prof. Saccardo has had the assistance of three excellent botanists. The Phalloideæ were taken by Ed. Fischer, and the remainder of the Gasteromyceteæ by Dr. DeToni. The Phycomyceteæ are made to include the Mucoraceæ, Peronosporaceæ, Saprolegnia-

[1] Saccardo, P. A.—Sylloge fungorum omnium hucusque cognitorum; Vol. VII, Pars I, Gasteromyceteæ, Phycomyceteæ et Myxomyceteæ, digesserunt A. N. Berlese, J. B. De-Toni et E. Fischer. 498, XXX pp., roy. 8 vo. Patavii, 1888.—33 francs.

ceæ, Entomophthoraceæ, Chytridiaceæ and Protomycetaceæ, and have been elaborated by Drs. Berlese and DeToni. The Myxomyceteæ were also done by Dr. Berlese.

Like the preliminary numbers of the series, this volume includes descriptions of all species of the groups named, so far as known to the authors. The compilation will be of the greatest service to the student, and enable him to do more accurate work with less loss of time than was possible heretofore.

Of course, in groups receiving so much attention as these do at present, the volume is scarcely published before descriptions of new species and revisions of genera call for addenda. It is to be regretted that the fine paper by Roland Thaxter, on the Entomophthoreæ of the United States, containing nearly a dozen and a half new species, did not reach the authors in time to be included.

Volume VI, on the Hymenomyceteæ, although it should have preceded the present one, has been delayed, but is expected to be out soon. The second part of Volume VII, just issued, will be reviewed next month; it embraces the Ustilagineæ and Uredineæ. The series is to be concluded with volume eight.

Minor Notices.

In some recent notes[2] on vegetable pathology, Dr. F. Cavara describes Dendrophoma Marconii, which infests the stalks of Cannabis sativa; Pseudopeziza Trifolii, that attacks Trifolium repens, Medicago sativa, etc.: Pleospora Trifolii, also found on Trifolium repens; Botrytis parasitica, which seriously attacks tulips; Basiaschum Eriobothryæ, found on leaves of Eriobothrum Japonica; and Pestalozzia Banksiana, on leaves of Banksia robus. All, excepting Pseudopeziza Trifolii, are recorded as new species, while Basiaschum Eriobothryæ constitutes a new genus.

In a reprint entitled "Botanical Notes,"[3] Miss Mary K. Curran gives much interesting information concerning the Pacific flora. It is a wonderful, and in many respects a very perplexing flora, and only an abundance of material and patient study can settle the numerous questions that arise. In the first part of the paper before us a list of plants from Baja California, collected by Walter E. Bryant, is given. Among them is a new species of Gongylocarpus, which demands a modification of the generic characters. The second part gives a synopsis of the Papavereæ of the Pacific coast. Dendromecon is placed in Hunnemanniæ, and Platystigma is merged with Platystemon. The numerous species of Esch-

[2] Cavara, Dr. Fridiano.—Appunti di Patologia Vegetale; alcuni funghi parassiti di piante coltivate. Extract from the Instituto Botanico della R. Universita di Pavia. Large 8vo. 14 pp. 1 plate. Milan, 18·8.

[3] Curran, Mary K.—Botanical Notes. Reprint from Calif. Acad. 2d Ser. Vol. 1., pp. 227-269. Issued Dec. 13, 1888.

scholtzia described by Professor Greene are all reduced to E. Californica, for which full reasons are given. The third part is entitled "Miscellaneous Studies," chief among which is the discussion of Mimulus. The proposal to divide the genus by restoring Diplacus and Eunanus to generic rank is not approved, and the observations given, on the whole, confirm Dr. Gray's conclusions, although they somewhat modify his sections.

NOTES AND NEWS.

W. L. GOODWIN, of Queen's University, Kingston, records (*Can. Record Sci.*, Oct.) the survival of a pine tree after girdling.

GARDEN AND FOREST has begun an interesting series of articles upon the elements of vegetable physiology, by Dr. George L. Goodale of Harvard University.

DR. JULIUS VON SACHS, the well-known professor of botany and director of the botanic garden at Würzburg, has declined a call to the University at Munich.

DR. DAVID DIETRICH, author of the extensive "Forst-Flora" and curator of the herbarium of the University of Jena, died on the 23d of October, in the 90th year of his age.

THE LAST ISSUED part of the *Journal* of the Linnean Society continues Forbes' enumeration of the plants of the Chinese region. The list has just reached the Compositæ. Many new species are described.

IN REVIEWING Wigand's *Das Protoplasma als Fermentorganismus*, Dr. Goodale (*Am. Jour.* Jan.) refers to an expression the author once used in conversation, "my whole life has revolved around Tannin, Darwinism and Bacteria."

IN THE *Journal de Botanique* (Dec. 16) Van Tieghem writes of hydroleucites and aleurone grains, and Lagerheim (of Stockholm) describes (with colored plates) a new genus of Chytridiaceæ, parasitic upon the uredospores of certain Uredineæ.

MR. ARTHUR HOLLICK records (*Bull. Torr. Club*, Dec.) the discovery of Quercus heterophylla, the famous "Bartram Oak," at Tottenville, Staten Island, N. Y., and in the same connection gives an interesting review of the literature of this oak and also of *Q. Rudkini* Britton.

AN ABNORMAL Rudbeckia hirta is reported by O. A. Farwell, of Phœnix, Mich., in which there are nine small heads sessile in the axils of the involucral scales of an ordinary head. They are 3 to 20-flowered, with 2 to 6 rays, and have an involucre of 3 to 8 equal scales in a single row.

DR. BESSEY reports (*Am. Nat.* Dec.) that the notable weeds of the Nebraska plains are as follows, supposably in the order of their unpopularity: Cenchrus tribuloides, Solanum rostratum, Helianthus annuus, Hordeum jubatum, and the two tumble-weeds, Amarantus albus and Cycloloma platyphyllum.

THE GAZETTE discovers that it owes its readers an apology for the miserable wrapping of the December number. The thing was so unusual that it excited remark, and we do not wonder. Were it possible we would duplicate the abused numbers. It was simply one of those mistakes for which no one seems to be blameworthy, but which will not occur again.

IN A PRELIMINARY communication[1] regarding his experiments in the Tübingen laboratory on the effect of the lower oxygen pressure on the movements of potoplasm, James Clark shows that when the pressure is reduced to 1.2–3.0 mm. of mercury all movement quickly stops.

C. WARNSTORF, of Neuruppin, Germany, asks the directors of herbaria and all bryologists to aid him with material for study of the Sphagnaceæ of foreign countries. He promises to use submitted material with the utmost care, and, unless otherwise specified by the sender, to return it after examination. He has in contemplation a *Sphagnologia Universa.* As Warnstorf is already known as one of the most thorough students of this perplexing group, we hope he will meet with a generous response to his request.

STAHL (*Bot. Zeit.* 1880) states that in Lemna trisulca the chlorophyll grains, which in ordinary diffused light are ranged upon the two walls of each cell lying parallel to the frond's surface, at night are driven to the side walls or lowest wall, leaving the superficial one bare. Mr. Spencer Le M. Moore (*Jour. Bot.* Dec.), in his observations on the subject, differs somewhat from these conclusions. His results show that while many of the grains are driven by darkness from the superficial to the side walls, many of them still remain on the superficial wall. This subject of photolysis is a very interesting one, and observers having duck-weed convenient would find in it a profitable field of investigation.

IN THE SEVENTH part of the Proceedings of the German Botanical Society (p. 248), Frank sums up his preceding observations and researches on mycorhiza, which go to show that the fungus of mycorhiza acts as a transporter of nourishment for the plants. Mycorhiza is most widely distributed. Specimens of tree roots from the most diverse parts of the world exhibit it, and the number of sorts of trees on which it has been found is now very large. (In the proceedings of the same meeting is published a paper by Alb. Schlicht, listing forty seven more species of herbaceous plants on which it occurs.) Mycorhiza is dependent for its development on the presence of humus in the soil, and therefore the fungus can not be a true parasite. The further facts that the roots at no time of year are free from the fungus, that roots thus invested do not perish sooner than others, and that cultivation experiments with beech seedlings show them poorly nourished without mycorhiza even in humus itself, all go to establish the symbiotic character of the association.

DR. ADAM PRAZMOWSKI discusses in an address delivered before the biological section of the Congress of Polish naturalists,[2] the nature and function of the root tubercles of the Leguminosæ. He has been unable to confirm Ward's observations as to the nature of the "bacteroid" bodies and the fungus itself. He considers that the tubercles are due to the attack of a special organism which may be said to belong to the fungi in the widest sense, but is not a hyphal fungus (Hyphenpilz), although in its young stage it occurs in the form of hypha-like filaments, which collectively form a sort of mycelium. It does not possess the characteristic membrane of the fungi, and in its older stages forms a sort of plasmodium. In many ways it approaches such Myxomycetes as Plasmodioi phora Brassicæ. As to the bacteroid bodies themselves, Prazmowsk- thinks that they can not be germs, because he has observed the formation of spores in the older and injured tubercles only, and because these

[1] Berichte d. deutsch. bot. Gesells, vi, 273.

[2] See the Botanisches Centralblatt xxxvi, 215, 248, 280.

bacteroids remain unchanged even after disorganization and putrefaction of the tubercles has occurred. The relation between the fungus and the host he considers one of symbiosis.

VOIGT HAS RECENTLY published his researches on the growth and development of seeds with ruminated endosperm belonging to the Palms, Myristicaceæ and Anonaceæ of Java. Among the Palms he distinguishes two cases: (*a*) with the prolongations of the seed coats cylindrical, without connection with the fibro vascular bundle of the testa, beginning at or before fertilization; (*b*) with the prolongations plate-like, or when less developed, swellings or ridges of greater or less breadth, inserted over the fibro-vascular bundle of the testa and receiving twigs from it. In Myristica fragrans the ovule has two integuments, but the inner covers only the upper part of the ovule. Soon after the opening of the flowers most of the tissues of these integuments and the nucellus passes over into permanent tissue, only the lower part of the outer integument and the lower part of the nucellus remaining meristematic. In the base of the nucellus, which grows very rapidly after fertilization, an outer layer (next the outer integument) and an inner layer (next the embryo sac) become permanent tissue, the former finally forming part of the testa. In this first men ioned layer a much branched vascular system develops connected with the vascular bundle of the rhaphe. Over the twigs of this vascular system arise projections which push themselves inwards deeply into the endosperm. In Anonaceæ the plates producing the "rumination" arise in four vertical rows by local growth of the outer integument. Each plate is thin and quadrant-shaped, with the central angle rounded. One of each row stands at the same height. A fuller abstract will be found in the *Botanisches Centralblatt*, xxxvi, 1314.

DR. J. H. WAKKER has an important paper in the final part of the nineteenth volume of Pringsheim's *Jahrbücher*, entitled, "Studien über die Inhaltskörper der Pflanzenzelle." The following translation of his summary of results will give an idea of the scope of the paper:

"Calcium oxalate crystals which are found inside the plant cell are formed exclusively in the vacuoles. The dragging of the crystals around by the movements of the plasma does not conflict with this fact [because in this case the vacuole divides and a small vacuole surrounds each crystal]. Aleurone grains are vacuoles filled with proteids. By the drying of ripening seeds the proteids become solidified, and by the softening which precedes germination the reverse takes place. In the formation of seeds the originally single vacuole divides into many, and in germination the reverse occurs, so that the emptied cells of the germinated seed again contain a single central vacuole. The proteids dissolved in the cell sap of ripening and germinating seeds can be precipitated by several reagents, viz.: dilute nitric acid, absolute alcohol, salt solutions, etc. By using these substances one can follow, step by step, the slow disappearance of the proteids in seeds kept in the dark. Globoids are formed in the vacuoles. Crystalloids can be formed in different places, viz.: in the vacuoles, the plasma, the nuclei or the plastids. Fixed oil is always formed in the plasma; either in specialized bodies (elaioplasts), or distributed through the plasma as in seeds. Plasma, during plasmolysis, can be perforated without causing its death."

It will be observed that this paper, together with that of Went, on the origin of vacuoles, in the preceding part of the same publication (see this journal, xiii, 280), extend our knowledge of the vacuole enormously, and show that it is much more than a space in the protoplasm formed by its inability to keep up with the growth of the cell wall.

Undescribed plants from Guatemala. VI.

JOHN DONNELL SMITH.

(WITH PLATES VI and VII.)

GUATTERIA GRANDIFLORA.—Arboreous: leaves shortly petioled, coriaceous, glabrous except pilose midrib beneath, obovate-oblong (6–8 inches), a third as broad, cuspidate: peduncle terminal, 1½–2 inches long, articulated midway, lanceolate bract an inch long: petals thrice exceeding ovate sepals, oblong (14–16 lines), obtuse, nearly equal, fleshy, fuscous-velvety, the 3 interior glutinose-papillate toward base within: berries few (10–12), glabrous, ellipsoid, each end obtuse, 10 lines long, half as broad, 4-times exceeding incrassate stipe; seed corrugate.—Pansamalá forest, Depart. Alta Verapaz, alt. 3,800 feet, May, 1887 (Ex Pl. Guat. Tuerckh., qu. edid. J. D. S., 1,235).—The few other species with shortly stipitate carpels, of which *G. Quinduensis* Tr. et Planch., seems the most nearly related, differ respectively, as described, by axillary inflorescence, or smaller flowers, or less elongate fruit.

CLIDEMIA CYMIFERA (§ *Sagræa* Cogn.).—Branchlets, petioles, leaf-veins and calyxes stellate-furfuraceous, rubescent: leaves a little or twice exceeding petioles, ovate-acuminate, 3–5 inches long, somewhat unequal in the pairs, 5–7-nerved from cordate base, glabrate above, margins scabro-ciliate: cymes from axillary bracteolate nodes pseudo-fascicled, at length 1–3 and pedunculate, trichotomous, 1½–2 inches long; axes divaricate, filiform, exceeding flowers, glabrous, red: calyx urceolate, teeth shortly subulate-appendaged: petals obovate-oblong (4–5 lines), twice exceeding calyx, roseate: anthers incurved, shorter than filaments, in-appendiculate connective not produced: ovary one-third free, conical apex glaucous: berry oval.—Rocks of a waterfall, Pansamalá, alt. 3,800 feet, June, 1885 (Ex Pl. cit. 709).

BLAKEA GUATEMALENSIS (§ *Eublakea* Triand).—Fur-

furaceous, anisophyllous: leaves glabrate, chartaceous, 5-nerved; the larger oval, caudate-acuminate, minutely cordate, 5 or 6 inches long, half as broad; the smaller ovate-lanceolate, 10–15 lines long: peduncles geminate or solitary, 1½–2 inches long, sub-equalling internodes: bracts 1-nerved; the exterior ovate-lanceolate, shorter than flowers, twice exceeding the obovate interior: calyx-limb narrow, sinuate: petals obovate-spatulate, nearly an inch long, roseate: anthers laterally connate, oblong, connective slender for the genus, its acutely conical spur a line long: style arcuate, elongate (8 lines), stigma capitellate: berry ribbed, 6-celled.—Pansamalá, alt. 3800 feet, Sept., 1886 (Ex Pl. cit. 778).—*B. gracilis* Hemsl., with nearly similar involucre, flower and fruit, is isophyllous, leaves acute at base, solitary peduncles several times exceeding internodes, bracts 3-nerved, anthers free and inappendiculate.

Explanation of Plate VI: Fig. 1. Flowering branch, nat. size. Fig. 2. Vertical section of flower. Fig. 3. Flower deprived of petals and stamens, enlarged. Fig. 4. Stamen, enlarged. Fig. 5. Diagram of flower.

Clibadium arboreum.—Tomentose: leaves scabrid above, hairy beneath, triplinerved, appressed-serrulate, ovate-acuminate, 5–7 inches long, base narrowed to nearly half as long as petiole: corymb large, flat, dense: heads subsessile, bracts ovate-oblong: involucre 3 lines high; bracts 9–10, pubescent, ciliate, firm, strongly nerved, obtuse; disk epaleaceous: fertile flowers 5, uniseriate; achenia large (1½ lines long), thick, winged below apex, black, shining: sterile flowers 10–11; corolla exsert, 1½ lines long, lobes puberulous; abortive achenia equaling the perfect, like them naked except glandular-pubescent apex.—Pansamalá, alt. 3,800 feet, June, 1886, (Ex Pl. cit. 929).—Remarkable by arboreous habit, as stated by Mr. von Türckheim. Other Central-American species, all suffruticose, the first nearly allied, may be distinguished as follows:

C. Surinamense L., var. *asperum* Baker. Petioles short, leaves rounded at base: heads smaller; involucral bracts 6-8, acute; palets 2–3, linear: achenia small, short obovate, dull-pale, upper half villose: corolla-lobes of sterile flowers conspicuously villose; abortive achenia hidden by shaggy hairs.

C. leiocarpum Steetz. Petioles very short, leaves narrowly ovate-lanceolate: heads small; involucral bracts glabrous, long-ciliate, bi-form, acutish: achenia broad, thick, black, apex naked and tuberculate.

C. acuminatum Benth. Petioles long: fertile flowers bi-seriate; sterile fewer (3-4), subsessile by short abortive achenia.

C. erosum DC. Petioles long, leaves unequally incised-serrate: heads distinctly pedicellate: fertile flowers bi-seriate, sterile 10–12.

NEUROLÆNA LOBATA R. Br., var. INDIVISA.—Glabrate: leaves membranaceous, scabrid above, broadly lanceolate, tapering finely to each end, lobeless: heads large.—Pansamalá forest, alt. 3,800 feet, April, 1887 (Ex Pl. cit. 1,223).—Approaching *N. macrocephala* Schz. Bip. in foliage and size of heads, but involucres remain distinct.

ARDISIA MICRANTHA.—Arboreous: leaves from short internodes, glabrate, coriaceous, obovate-elliptical, 4–6 inches long, acuminate, narrowed to short margined petiole: panicle terminal, subsessile, exceeded by leaf; branches complanate, margined, alternate, sub-simple, closely racemose-flowered toward apex; pedicels exceeding ovate alabastra, bractlets small: calyx-divisions ovate, ocellate, glandular-ciliate: corolla twice longer (2½ lines), lepidote without and toward base within, sub-partite, segments oblong-ovate: stamens exceeding corolla, at length long-exsert, cordate anthers ¼ line long: style shorter than corolla, ovary rubro-punctate.—Coban, Depart. Alta Verapaz, alt. 4,600 feet, March, 1888 (Ex Pl. cit. 1,365).—*A. compressa* HBK., and *A. revoluta* HBK., with somewhat similar foliage and panicles, are distinct by anthers equaling or exceeding filaments; *A. bracteosa* A. DC., with nearly similar stamens, has sessile flowers exceeded by their bracts, tubular calyx and corolla acutely cleft.

TOURNEFORTIA BICOLOR Swz., var. CALYCOSA.—Calyx-segments glabrate, linear, two-thirds as long as corolla.—Pansamalá, alt. 3,800 feet, July, 1886 (Ex Pl. cit. 980).

IPOMŒA DISCOIDESPERMA (§ *Strophipomœa* Chois.)—Leaves twice exceeding petiole, entire, ovate, caudate-acuminate, base truncate, 3½–4½ inches long: peduncle exceeding petiole; pedicels 2–3, shorter than calyx, tetragonal-incrassate above, bracts minute: sepals elliptical, an inch long, smaller within: corolla yellow, infundibular, 2 inches long, tube short: stamens equal, one-fourth as long as corolla; filaments dilated at base, more than twice exceeding oblong anthers: style shorter, stigma 2-globose: disk large, pulvinate: ovary 2-locular, 4-ovulate, ovules arachnoid: capsule coriaceous, globose, over an inch in diameter, 1-locular,

4-valved: seed 1, oblate, an inch broad, half as high, black, velvety.—Pansamalá, alt. 3,800 feet, June, 1885 (Ex Pl. cit. 744). Collected also by Dr. Sereno Watson (412 Fl. Guatemala. Yzabal, Apr. 1885). The tardily dehiscing capsule exhibits scars of three obsolete ovules; vestiges of the dissepiment appear in the form of a narrow ring encircling the seed, free from both it and the septa, and attached only at the conspicuous hilum.

The eccentric seeds justify the conjecture that this is the plant known only by its capsules in Kew herb., which is referred to as follows by Seeman (Bot. Voy. Herald), and which has not been cited by later authors: "683. Ipomœa sp. Nomen vernacul. *Boton de terciopelo*. Veraguas. The capsule of this species is quite glabrous, but the seeds are densely covered with short, stiff, black hairs, giving them the appearance of black velvet buttons."

SOLANUM SIDEROXYLOIDES SCHLECHT., var. OCELLATUM.—Leaves elliptical, acuminate, base rounded, nearly smooth above, pubescent beneath, veins tomentose: calyx-teeth replaced by conspicuous black globose intramarginal glands.—Pamsamalá, alt. 3,800 feet, May, 1887 (Ex. Pl. cit. 1,155). Schiede's original of Schlechtendal's description has been compared in the Berlin Herb. by Prof. Urban with the above, and fragments communicated by him. It differs only by more manifestly ovate and acuminate leaves floccose beneath, and minutely-toothed calyx. To the typical form seem referable 827 Botteri, 2,837 Bourgeau, 923 Türckheim; also the following unnamed specimens at Kew (not cited in *Biologia Centrali-Americana*), which have been compared by Dr. N. L. Britton: 1,157, 1,172 Galeotti; 233 Linden: 855, 856, 857, 897 Botteri.

SOLANUM OLIVÆFORME.—Herbaceous, glabrate, repent, 2–3 feet long: petioles margined, amplexicaul, 1–2 inches long; leaves minutely lepidote above, pale-glaucous beneath, trisect, cordate; leaflets obtuse at each end, contracted to margined petiolules; the terminal rhomboid 12–18 lines long; the lateral half as large, sub-opposite, oval, inæquilateral, base truncate on upper side and produced on lower: peduncles extra-axillary, sub-equalling petioles, exceeding 3–5-flowered scorpioid cyme: calyx-teeth triangular: corolla-segments linear-oblong (3 lines): anthers oblong, dehiscence longitudinal: berry ellipsoid, over an inch

long, nearly half as broad.—Mountain-precipice in Pansamalá, alt. 3,800 feet, May, 1887 (Ex. Pl. cit. 1,226).—The Bolivian *S. tripartitum* DC., which seems to be the most nearly related species, has, among other differences, pisiform fruit.

TETRANEMA EVOLUTA.—Leaves membranaceous, reticulate veins beneath and erose margins pubescent: peduncles ex-alate, shorter than leaves, sub-equalling paniculiform scorpioid cymes, elongate axes 2–4-nate: calyx-segments attenuate, 3–4 lines long: corolla nearly an inch long, white with purple spots: capsule ellipsoid.—On rocks, Pansamalá, alt. 3,800 feet, May, 1887 (Ex. Pl. cit., 1,218).—The generic character drawn strictly from the sub-capitate umbelliform inflorescence of the monotype, *T. Mexicana* Benth., needs enlargement to include this second species. The former differs also by glabrous fleshy crenulate leaves exceeded by margined peduncles, shorter calyx, smaller corolla, globose-ovoid capsule.

LOUTERIDIUM DONNELL-SMITHII, Watson, Proc. Am. Ac. xxiii, 284.—The author of this recent genus makes the following correction in one of its characters: "The upper sepals were described as distinct, and the three lower as united. The reverse is the fact. The third broad and apparently simple sepal is posterior, while the two lower, which remain distinct, are lateral, one upon each side of the sac of the corolla." In examining Dr. Watson's own undetermined collections in Guatemala this plant has been found to occur as "No. 292, Banks of Chocon river, Depart. Yzabal, March 1885."

Explanation of Plate VII: Fig. 1. Cyme and leaf. Fig. 2. Flower with calyx removed and corolla laid open. Fig. 3. Vertical section of ovary. Fig. 4. Ovule. Fig. 5. Capsule divided transversely. Fig. 6. Dehiscent capsule. Fig. 7. One valve showing placenta and retinacula. Fig. 8. Seed divided transversely. Fig. 9. Embryo. Fig. 10. Diagram of flower. (Figs. 1, 2, 5, 6 and 7 are natural size; the others are variously magnified.)

SCUTELLARIA ORICHALCEA.—Suffruticose, a foot high, pubescent: leaves minutely scabrid above, pulveraceous beneath, oblong-lanceolate, obtuse, coarsely toothed, 16–21 lines long, 2–3 times exceeding petiole: raceme terminal,

secund, equalling leaves; flowers 12–15, pubescent, alternate and opposite, twice exceeding foliaceous bracts: calyx 2 lines long, equalling pedicel: corolla yellow, 10 lines long, tubular nearly to lips and half a line wide; posterior lip 1 line long, united with equal lateral lobes, nearly twice exceeding patent anterior lip: filaments scarcely margined; anthers ciliate.—Rock-crevices, Chajrax, Depart. Alta Verapaz, alt. 2,000 feet, Dec., 1887 (Ex Pl. cit. 406).—Affinity is with the recently described *S. lutea*, Botan. Gaz. xiii. 76; but conspicuously different by filiform corolla.

DAPHNOPSIS RADIATA (§ *Nordmannia* Benth. et Hook.).—Fruticose, younger parts and inflorescence sericeous-pubescent: leaves coriaceous, smooth and shining above, paler and veiny beneath, oblanceolate, 8 or 9 inches long, 2 inches broad, each end acutely attenuate, sessile: peduncles extra-axillary, 1½–2 inches long, terminated by a globose 35–38-flowered umbel 16 lines in diameter; pedicels filiform, twice exceeding flowers: pistillate perianth urceolate-fusiform, roundish unequal lobes ½ line long: staminodes most minute: style equalling sub-stipitate ovary, large globose stigma included by connivent perianth-lobes: staminate flowers not seen.—Mountain-forest, Coban, alt. 4,600 feet, Feb., 1888 (Ex Pl. cit. 1,163).—Well marked by large leaves, numerous elongated pedicels, small perianth-lobes, long style.

HYPOXIS RACEMOSA (§ *Euhypoxis* Baker).—Tuber oblong, ⅜ inch thick, neck elongate: leaves plicate, carinate, 7–9-veined, a foot or more long, 6 lines broad: scapes 5–6, sub-erect, a third shorter than leaves: racemes densely villose, 2–3 inches long, 7–8-flowered; pedicels equalling bracts and internodes, alternate above: exterior perianth-segments green on face with colored margin, linear-lanceolate, 5 lines long, 1 line broad; the interior a little smaller, more than twice exceeding stamens: style with stigma equalling filament: ovary trigonal, equalling limb.—Coban, alt. 4,300 feet, May, 1886 (Ex Pl. cit. 33).—A more robust plant than any forms of *H. decumbens* L., and distinct from the var. *major* Seub., by rhizome, distinctly racemose inflorescence, long-pedicellate flowers, elongate perianth. Collected also in Mexico by Botteri (80, 455, 463).

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On Cuscuta Gronovii.

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(WITH PLATE VIII.)

For a parasite that is parasitic from its heart and with all its heart, after having tried an honest life, there is perhaps no better example than dodder, which in our region (S. Hadley, Mass.) is Cuscuta Gronovii. We find it in abundance in autumn, early and late, twining its orange-colored stems about grass, solidago, alder, and the like, with a glory of white, bell-shaped flowers, in cymose clusters, appearing as lateral buds in the axils of bracts.

In preparing for the study of Cuscuta, fresh plants were placed in alcohol, some were dried—as gathered on the host—and seeds were sowed in pots. From the first, imbedded in celloidin, slides were prepared. The dried specimens yielded knowledge of external parts and abundance of seeds, which were valuable in ways that will appear later. The seeds are exalbuminous, of comparatively large size, with a conspicuous hilum and hard testa; but the latter yielded readily to soaking in dilute potash, and careful dissecting removed the two coats and freed the coiled, snake-like embryo (fig. 1). The root end of the embryo lies outermost, and is slightly enlarged, more noticeably so after germination, when it evidently remains, for some time, a store-house of nourishment.

The time required for germination was found to vary much. Some of the autumn-gathered seeds germinated in three days, after a few days' soaking; others, obtained from alder twigs out of doors, in February, and sowed dry, were three weeks in showing signs of life. The end of the stem which first emerged from the seed-coats was very soon covered with numerous short rhizoids, and careful observations failed to discover any trace of a root-cap. Figs. 2 and 3 illustrate seedling dodders. The tip produces, even at a very early stage, the rhizoids mentioned. Comparing fig. 3 with fig. 1, it will be seen that the root-hairs must have grown very rapidly, none being on the embryo, just before germination. Fig. 2 is the root end of a seedling 2 inches long, and hence the rhizoids are much further developed. Fig. 5 illustrates one of the most interesting things in my study of the plant, and one that I could not find mentioned by any

observer, viz., a method by which the plant cut itself off from normal nutrition. Having reached some suitable host—a twig of Forsythia viridissima in this case—it twines around it like a tendril, by two or three coils, and in coiling contracts so as to draw itself nearer the host. This contraction, if the seedling is not too deeply rooted, or too slack between the soil and the support, pulls the roots from the earth and leaves the plant—a parasite by suicide—with roots at varying distances above the soil, ¼ of an inch being perhaps the highest I observed. If the plant is not uprooted in this manner or by the lengthening of the internode of the host to which it is attached, as sometimes happens, the lower part of the stem dies, and the connection is thus severed with the absorbing root, not, however, until the enlarged portion of the stem has been drained of its nourishment or the plant has reached some other supply. All the plants that germinated earliest, of those we studied, hung themselves; the later ones—those washed deeper into the soil—died at base. Our gardener, noticing the hanging ones, said, "Those are not plants; they crawl up sticks like an inch-worm." These germinating plants are white below, but yellowish-green at summit, suggesting that the dodder, even in its degeneracy, has some chlorophyll and may elaborate food for a short time. The amount of nourishment stored in the embryo hardly seems sufficient to enable the seedling to produce such a length of stem before reaching a host, as is done by some. Other things, too, indicate ability to assimilate, such as the greenness of buds and branches for some time after they appear. This coloring matter is removed by alcohol.

To illustrate the rapidity of growth after germination, I give the statistics of a single plant, grown in my own room under a bell-jar, in circumstances perhaps not the most favorable, as there was much variation in temperature, especially at night. The seeds were collected out of doors on some alder twigs, and sowed immediately, February 29. The first plantlet appeared at the surface of the soil March 20, and twenty-four hours later, at 8 A. M., March 21, was one inch long, with tip doubled back and coiled once about itself like a whip upon its stalk. All was white but the coiled tip. At 10 A. M. it had more nearly uncoiled and had gained one-fourth inch in length in the two hours; at twelve it was erect and slightly elongated; at 6 P. M. its length was one and one-half inches and its inclination toward the nearest host. Measurement at 8 A. M., March 22, showed it to have

gained three-fourths of an inch in twenty-four hours—one-third of that length between 8 and 10 A. M. Careful observation between the corresponding hours the second day showed the same gain, suggesting, what experiments with other seedlings seemed to corroborate, that 8 to 10 A. M. represented the maximum period of growth. The plantlet was then, at the height of two inches, touching its host. Contact caused it to coil like a tendril, although it was several times disturbed and shaken from its support, so that at 8 A. M., Saturday, the 24th, three days after germination, it was fast to its host with two close coils about the stem. Growth in length now ceased for several days, all its energy being expended in producing suckers and thrusting the haustoria into the host. March 26 the suckers were well developed, the root portion was brown and useless, the reservoir above the rhizoid portion exhausted of supplies and the plant apparently in position for an easy life. During this time the nutation of the tip of the seedling was opposite to the course of the sun.

From observation upon this and other plants it was evident that there is a limit to the size of stem they are able to encircle, and that the diameter must be small. One that I noticed attempting to surround a large geranium stem was unequal to the task, and coiled back upon itself twice upon the side of the trunk. Plants showed very little discrimination in the selection of hosts, attacking everything that offered support—dead and dying stems, as well as fresh ones, and even the rim of the flower-pot. They usually recoiled after one turn about a dead twig, and extended the tip further unless the root had been lifted from the soil. When a suitable host was obtained, the tip nestled down close to it and did not attempt further wandering.

We failed, for a long time, in all our attempts to cultivate the dodder—further than to obtain a few coils about the stem. We never suspected the unsuitable character of the hosts, as out-door dodders do not seem particular. But an enterprising seedling taught us the lesson by seizing a young geranium petiole, just emerging from the bud, and beginning to grow by feet in the same pot where a Eupatorium-entertained companion, of the same age, grew scaly, stubby and by inches, and all others died. After this there was no difficulty in raising dodders.

The suckers are, outwardly, enlarged fleshy disks, which the parasite forms and presses hard against the host, sending

into it from their center organs called haustoria by which they asorb the elaborated juices as roots take moisture from the soil. They differ from true roots, as does the root-acting end of the stem, in the absence of a root-cap.

An attempt to remove the dodder from a stem to which it is well attached often ends in taking with it at least the cortex of the plant on which it grows. Sections either longitudinal or vertical through the parasite, in position on its host, median as regards a sucker, will explain this. Each sucker starts, as does a root, in the vascular tissue of the stem, and is a cylinder, sharpened like a blunt pencil where it enters the host and enlarges immediately afterward. Thus is made a sort of neck about which the epidermis of both host and parasite fit very neatly; the sudden enlargement of the latter, in its new quarters, serving, as does a nut on a bolt, to prevent its easy removal.

The suckers, in their origin, are domes of meristem tissue before they reach the epidermis. Whatever lack of discernment the dodder may show in its selection of a host, once well placed, it lives up to its opportunities. It may, and usually does, in a woody stem like that of Solidago, send one root into the center, as if for deep anchorage, but spreads out by far the larger portion of its absorbing tissue in the cambium and sieve-tube regions where elaborated material is most abundant. Its tissue is easily distinguished from that of the host by its enlarged thin-walled cells with prominent nuclei. When the cutting was exactly median, the tissue seemed like a compact cylinder made up of filaments or cells, end to end, like meristem tissue, which branched, however, in a variety of ways inside the host. When growing on hollow stems like grasses, as it was common to find them, the haustorium scarcely branched, there being little opportunity.

One of the most singular phases of dodder life was a sort of self-grafting or self-parasitism. With a low power it was difficult to distinguish which was host and which guest, as the haustorium extended from the vascular region of one stem to the same of another. In examining the alcoholic specimens, I found this common, and it has often been repeated on those growing in my own room, usually under such circumstances as these: If a parasite had occasion to twine about an already thickly covered host, in its anxiety to obtain its share of elaborated material, it was willing to take a sort of second mortgage upon it, after it had passed into

the tissues of the first; this inter-parasitism also occurs frequently when for a long distance stems intertwine.

There is little differentation in the tissues of the dodder; it needs, very early, conducting tissue for carrying moisture through the stem to the rapidly growing and probably assimilating apex. To meet this need vascular tissue is found as soon as germination takes place. It is very simple, consisting of alternate stripes of tracheids and parenchyma, each about two rows of cells broad, and in the best developed stems occupies perhaps from one-third to one-half the diameter. It is well adapted for twining by this alternation with the softer parts, while the predominance of the latter favors the carrying of elaborated material, as it is in these such products travel. Iodine testifies to the presence of starch in the tissues of mature plants. Other reagents show, as do the markings on the walls, the woody nature of the alternate bands evident in a section of stem.

Of the adventitious buds, known to be abundant in the dodders, I have studied only those producing branches.

Their origin was in this manner: When a parasitic root had become well established, so that the plant was thoroughly engrafted upon the host, in an axil thus formed, a branch would arise, after the manner of an axillary branch on a normal plant. The regular branching of a stem of Cuscuta is unusual in the centrifugally arranged accessory buds (figs. 6 and 7), the last formed bud being farthest from the parent stem, though sections show it to originate in the axil bundle.

The epidermis of dodder varies with its position. On the long internodes between adjacent scales stomata are rare, while over suckers, *i. e.*, on the side of the stem opposite them, very small stomata are quite abundant. This explains, in a measure, the continuance of life and growth for two weeks or more in branches cut from the parent stem and suspended in the air, though such stems never form coils or suckers.

Each flower has a short pedicel like the main stem in structure, a thickened receptacle, a five-lobed calyx and corolla with beautifully branched fringes lining the latter, and adherent stamens alternating with its lobes; the ovary has two cells with two ovules in a cell, and there are two knob-like stigmas on short styles. As to the manner of fertilization of the dodder, whether self or cross fertilized, I have had no opportunity to observe.

The two-celled ovary is composed of two carpellary leaves, with two cushion-like basal placentæ, each bearing two ovules, though at maturity there is often but one. The sections of placentæ are deceptive when the ovules are absent, having much the appearance of young ovules. The study of the ovules with reference to the layers in the seed coat gives evidence that in the mature testa there are three. The outer is quite unlike the two below, which are, perhaps, divisions of the same cell layer. They probably arise and cover the nucellus in an early stage, but are not differentiated into the mature form until a late period in the maturity of the ovule.

A short distance below the apex of each mature embryo, and always on the inside of the curve, as it lies coiled in the seed, is a well-developed scale (figs. 8 and 9, *a*). Another scale almost as well developed is usually to be found slightly below the apex of the embryo, but on the outer side of the curve (figs. 8 and 9, *b*). These two are separated by quite a portion of the stem in length, and in some cases the second scale is only partially differentiated, and yet a part of the tip, whose tissues, under a high power, are evidently of scales in process of formation. In no case were the scales opposite, or approximating it, as a pair of cotyledons would stand. What may be their relation to the embryo, I do not know, but the apex with its forming scales, of which this second one is sometimes a part, could well be a plumule. Comparing seedlings two inches in height with the embryos, the scales were evident (at least always the inner one), and at a distance from the growing tip corresponding to the increased length of the plant. They in every case soon turned brown.

How the dodder became a parasite is an interesting theme, and pleasantly treated in an article in the *Popular Science Monthly*, Vol. XXV. A weak stem, desire to reach the light, twining to accomplish this, and tasting juices by chance, they were nourished by them and given a tendency which increased in favorably situated descendants until, as Drummond states: "Henceforth to the botanist the adult dodder presents the degraded spectacle of a plant without a root, without a twig, without a leaf, and having a stem so useless as to be inadequate to bear its own weight." So it stands a monument of degeneration. Other plants with smaller beginnings have gone on to higher forms, while the dodder, as Prof. Drummond again, in substance, says, from

a breach of the laws of evolution, pays one of Nature's heaviest fines—loses the organs it once had.

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EXPLANATION OF PLATE VIII.—Fig. 1, mature embryo, dissected from seed. Fig. 2, tip of root of *a*, fig. 5. Fig. 3, enlarged view of 4, an embryo one-half nat. size, just escaped from seed coats. Fig. 5, seedlings, one-half nat. size. Figs. 6 and 7, accessory branching. Figs. 8 and 9, tips of embryos, enlarged; *a*, inner, lower scale; *b*, outer scale.

Development of cork-wings on certain trees. V.

EMILY L. GREGORY.

Passing now from stems of this type to those of Liquidambar, it is readily seen that whatever may be the end results, the immediate causes producing the wing are not the same as in the former type. Its eccentric development is a marked peculiarity, which, so far as I have been able to discover, occurs in no other instance. The question at once arises, whether the causes which produce eccentricity of growth in the annual rings of wood are likely to extend to the tissues arising from the cork cambium. If this were proven to be the case it might help but little in solving the problem before us, as it is a well known fact that the best authorities do not agree as to the causes of eccentric growth in woody tissues.

The function of protection which is universally assigned to the periderm naturally requires greater flexibility of structure, varying degrees of thickness, greater or less permeability for water and gases according to varying outward conditions, and, finally, greater or less outlay of material, which, in some cases, is retained, in others, discarded by the plant after it has performed its function. In this way it is easy to account for the variableness in periderm formation as illustrated in the genus Euonymus. This is more striking when contrasted with the uniformity prevailing in the structure of woody tissue. For example, when examining a large number of woods in regard to the presence or absence of bordered pores in the libriform, it was found quite unnecessary to carry the study farther than the genus. If a single species contained libriform with bordered pores, this was sufficient for the genus.

Several theories respecting eccentric growth fail at once when applied as a reason for the one-sided development of the Liquidambar wing. For example, that of gravity, which tends to produce a greater deposition of food material on the under side of horizontal branches. The wings never start from the under, but always from the upper, side of such branches. Another theory is that unequal pressure of the rind causes the inequality of growth of the ring, which is equally inapplicable in the present case. The agency of light seems a plausible theory in respect to the wings on the horizontal branches, but fails to explain their appearing first on one side of the young main axis.

On the other hand, if it be regarded from the standpoint of utility, as a contrivance to further the welfare of the plant, the question is again extremely puzzling. The probability of its serving to facilitate the interchange of gases, or affect transpiration in any way, seems much less likely than in the preceding instances. To those advocating the theory of water absorption, by various contrivances on leaves and stem, the trough-shape which the wings assume suggests the possibility of their use as water reservoirs and conductors to those parts of the stem where the water may be taken into the interior. This view is mentioned rather as a fanciful suggestion than otherwise, though both morphology and anatomy go to show the possibility of the tree making this use of the wing. It is just possible the suggestion is not more unreasonable than some similar ones made in reference to various appliances for making use of water.

There is, however, another view which suggests itself, and that is, the wing may be regarded as a contrivance for local increase of circumference without affecting the working quality of the remaining part of the periderm. By referring to fig. 18 it will be seen that on a four years' stem the circumference has been increased nearly one-half by the growth of the divided wing, the rest of the circumference remaining in the same condition as in the first season. Other branches are often nearly covered with the wing development, leaving only a narrow strip of circumference in its early condition. With increasing age comes increasing demand for protection, especially in case of the main axis. This is supplied by the corky growth extending itself to the whole circumference, while the interchange of gases is rendered possible by the breaking of tissues down to the new tender-walled cells near the phellogen layer. This tree is one of those described by

Moeller as having an internal periderm, or what is the same, producing a bark. What the connection is, or whether the knowledge of the exact structure of the internal would throw any light on the function of the superficial periderm I am not able to say.

In Euonymus alatus we have not the puzzling feature of eccentric growth, but the question of utility and the reason for such an outlay of material arises with still greater force. Here the last suggestion in reference to the wing of Liquidambar may be applied. In all the species of this genus it is an evident fact that the stem performs, in part, the office of assimilation. This is especially marked in the case of E. alatus, the chlorophyll-holding cells even having the form and arrangement of the regular palisade cells of leaves, while the number and size of leaves indicate the need of the aid of the stem in performing this labor. Now in stems even with the most exaggerated wings, both as to width and depth, it is still very evident that the entire surface, which acted as assimilating tissue before the beginning of the wings, still retains its original character and sustains the same relation to the outside air as before, during at least the first two years' growth of stem. By referring to the figures the comparatively immense gain in surface by the wing development is seen, while the surface, with the original palisade cells, remains intact and in working order. Now, were the material in these wings evenly distributed around the stem early enough to allow its growth in diameter, all assimilation of the stem would be effectually checked. By the present arrangement, the protection of a partial superficial periderm is given to the stem, assimilation is not checked, exchange or gases goes on by means of the stomata and whatever there may be taking place through the young tissue of the wing lying in lines along near the surface. It will be remembered that these walls are never suberized. The anatomy of E. Europæus and its varieties indicates a similar function. Surface growth is increased here with less outlay of material than in E. alatus, the wings never acquiring such size in the direction perpendicular to the surface.

The development of cork tissue from its beginning, was studied only in the two forms given, E. alatus and E. Europæus, var. purpurea; in these the origin of the phellogen cells was not the same, those of the first occurring about the stomata, and of the second in the thick-walled collenchymatic cells of the corner. Therefore it is not safe to draw

conclusions concerning the other species where corky projections occur, but which assume other forms than wings. The so-called warty excrescences on the stem of E. verrucosus, examined after they were fully developed, showed no difference between these and the ordinary cork formation, and no traces of lenticels from which they are said to arise. One species, E. Americanus, usually shows very few traces of corky growth on its young twigs, and never, so far as I can learn, produces the wing form. Some young stems were found, however, with a distinct line of corky growth so small as almost to require the lens to render it visible. This line was neither along the corners, as in Europæus, nor exactly between them, as in alatus, but ran close along the side of each corner. This suggests very strongly the idea of transition stages. The great variety in the matter of periderm formation within this genus suggests a fertile field for farther examination.

It is quite possible that undue importance has been attached to the fact of the difference between the fall and summer growth of cells, and that the walls of the few layers of plate cells are always suberized, while those of the summer's growth for the most part show little traces of suberin. The regularity with which this occurs, and the complete encircling of the stem by one or more layers of suberized cells during the winter, seem almost conclusive evidence that this is to protect the stem during its period of winter rest, and indicates also the demand for a greater supply of air in summer than in winter. This regularity, together with the fact that in all cases studied, except the one previously mentioned, the number of the year's rings of cork agreed with that of the woody tissues suggested that the immediate cause producing these results might be the same. That is, the immediate cause producing the shortened radial diameter and usually thickened wall of the libriform cells, and the absence of tracheæ in the fall growth of woody tissue, might also be the cause of the shortened radial diameter and usually thickened wall of the fall growth of cork. Up to this time we have used the terms fall and summer growths loosely, referring to the later and earlier growth of the season. Now unless it can be proven that the time of this change of growth actually corresponds in both cases, it is evident there is nothing in the above suggestion, however plausible it may appear. This was attempted only in the case of Liquidambar, as the two other types were not available for constant daily study.

Sections cut from different Liquidambar trees, at different dates along the course of the summer's growth, and extending late into the fall, proved that the narrowing of the wood cells occurred at the same time as that of the cork cells. The work was begun too late in the season for the examination of the beginning of growth in the spring-time. Exact correspondence in time is not necessary, however, in case of the beginning of spring growth. Even were it proven that the real cambium resumed its activity a few days earlier or later than the cork cambium, this is no argument against the above hypothesis of the same cause acting on both kinds of cambium after both have been active during the summer.

Perhaps a partial apology should be made for offering the suggestion, as it seems hardly possible that this change from summer to fall growth in cork formation, which has so often been given as one of the important characteristics of cork, should not have been used in the recent investigations about the question of annual rings of wood, unless this question of correspondence in time had been thoroughly tested and found to fail. In all the recent literature to which I have had access I have found but one allusion to this, that is in the article by Gerber, before referred to. He says: "The early and late cork is like summer and fall wood, but that the time of their formation is not the same." Then he explains that the time of the beginning of the formation of the spring wood does not correspond with that of the formation of spring cork, but says nothing whatever respecting the time of beginning of fall growth.

In connection with this, a brief summary of the views about the cause of the difference between the spring and fall wood may be excused here. Sachs's theory, stated in the first edition of his text-book, was that the peculiarity of the fall wood was due to the increased pressure of the rind at that time. Later experiments have failed to support this view. Among the first objections to this theory was the frequent occurrence of double year's rings. An article by Prof. Kny[7] on this subject, written in 1880, contains a statement of previous authorities, together with his own investigations, showing conclusively that double year's rings occur. Russow,[8] in an article in 1881, speaks against the theory of

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[7] L. Kny Verdoppelung des Jahresring. Verhandlung d. bot. Vereins der Provinz Brandenburg, 1880. p. 1.

[8] Russow. Entwickelung des Hoftüpfels der Membran der Holzzellen und des Jahres ringes bei den Abietineen. Sitzungsber. d. natur. Ges. Dorpat, 1881. Bd. 6. Heft. 1.

rind pressure in this way: First, if this be the explanation, then it must have its effect in the rind formation, that is, there would also be year's rings in the tissues growing from the opposite or phloem side of the cambium, which does not occur. Secondly, there must be a gradual going over to this shortened diameter, as the pressure increases gradually. This is not the case. Thirdly, the pressure of fissures made in the rind by the frost is supposed to account for the diminished pressure in the spring time, but this fails to account for the fact that in the hot zones year's rings have been known to form the same as in colder climates. Russow suggested that instead of pressure on the cells from without, it was caused by a diminished turgescence within the cells, that the decrease in the amount of nourishment was the cause of this lack of turgor. Krabbe[9] next proved that the rind pressure is only very little greater in the fall than in the spring, so little as to make it impossible to be the cause of the short diameter. Moreover, the rind being cut so as to lessen the pressure rather tended to favor the production of the fall wood. Next, Wieler experimentedas to the relative turgescence of cells of spring andfall, and proved this to be about the same during the entire vegetative period, therefore he claims there must be some other cause for the manner of growth of fall wood. He holds, with Russow, that the spring wood is better nourished than that of the fall.

In a review in the Bot. Centralblatt Bd. 34, no. 2, 1888, Sanio gives a brief summary of the conflicting opinions of Wieler and Krabbe. The latter states, we have now two theories as to the cause of the fall growth of wood, viz.: Wieler's and Hartig's. Both claim it to be the varying conditions of nutrition in the fall and summer; but the one, Hartig, says the tree is better nourished in the fall than in the spring; the other holds the contrary opinion. Hartig claims that the increased nourishment of the fall is used in adding to the thickness of the wall; Wieler explains the shortened radial diameter as due to the decrease in nourishment offered in the fall, and that the thickness of these walls depends on nourishment already acquired by the tree, and that their growth in thickness is quite independent of their growth in surface. He also claims that the greater or less number of ducts is a thing "per se," that it is not a constant factor in the problem, and does not attempt an explanation of this

[9] Krabbe. Ueber das Wachsthum des Verdickungesringes und der jungen Holzzellen in seiner Abhängigkeit von Druckwirkung. Abhandl. d. Akad. d. Wiss. zu Berlin, 1884.

feature. Krabbe criticises these views, and insists that an attempted explanation of the cause of fall wood should include all the characteristics. The reviewer favors the opinion of Wieler.

These few statements contain, perhaps, the principal results hitherto attained in this direction. If it could be proven that in the majority of instances the time of change from summer to fall growth of wood does not correspond exactly with that of the change in the cork tissue, the question would then arise as to the cause of the latter. It is certainly very significant that the only constant feature, viz.: shortened radial diameter of cells, is common to both, and furthermore, that the walls of the fall cork cells are often thicker than those of the summer growth, which is so frequently true of the fall cells of wood.

On the other hand, if it could be proven that the time of this change does correspond, there would be strong reason for supposing the cause to be the same. This would invalidate the theory of rind pressure, and add much in favor of the opinion that the question is solved whenever the cause of the shortening of the radial diameter is discovered.

Owing to the difficulty of access to the living specimens at proper times for experimenting but little could be done in that direction. It is, therefore, scarcely proper to speak, in conclusion, of definite results. Various facts in regard to the anatomy of these growths have suggested certain inferences, some of which are of such a nature as to be easily proven or disproven. The most important of these are:

I. Young stems, which are entirely encircled by cork wings, were found to lack other means of communication with the outside air. The anatomy of the wing in these cases is such as to enable it to supply this deficiency and to act as lenticels.

II. The wings of the horizontal branches of Liquidambar, covering as they do only part of the circumference, perform in part the same function, at the same time they increase the surface sufficiently to allow the growth within, while the remaining part of the stem's surface retains the character and office of the early periderm.

III. In Euonymus, the symmetry of the stem is preserved, the surface is enlarged by the wing, while all the remaining surface of the stem plays the part of assimilation.

IV. The characteristics of fall cork are exactly those of fall wood, the tracheal element alone excepted. Could it be

proven that these changes were due to the same cause, another means of deciding the question as to the cause of the fall growth of wood, or year's rings, would be obtained.

In concluding, the author begs leave to express thanks for all assistance from friends, in the way of material kindly furnished from various sources; especially to Dr. C. S. Sargent and to Mr. Meehan, of Philadelphia.

Biological Dep't, Univ. of Penn.

ERRATUM.—Page 252, line 23d from top, should read, According to the *place*, etc.

Notes on North American Mosses. I.

CHARLES R. BARNES.

About a year ago, Mr. F. H. Knowlton, of the National Museum, sent me a package of mosses collected in August, 1887, by William Palmer, mostly on the Mingan Islands, which lie between Anticosti and the southern shore of Labrador. As the publication of the bulletin concerning this collection is delayed, it is thought best to publish the list in the GAZETTE. It includes one new species.

1. *Sphagnum papillosum* Lindb. In wet woods mixed with No. 8. St. Johns, Newfoundland.

2. *Gymnostomum rupestre* Schleicher (1807). On limestone cliffs, Mingan. This is one of the forms of this polymorphous species approaching G. curvirostrum closely, but it seems hardly worth while to give it a name.

3. *Dicranum undulatum* Ehrhart. Sand beaches, among trees, Mingan. This is the D. undulatum of Lesquereux and James's Manual. *D. undulatum* Turner is *D. Bonjeani* De Not.

4. *Bryum inclinatum* Br. & Sch. On limestone cliffs, Mingan.

5. BRYUM KNOWLTONI. (§ *Cladodium.*)

Plants densely cespitose; tufts 1–2 cm. deep, interwoven with red-brown rhizoids, mottled. Stems copiously branched by innovations, reddish. Leaves closely imbricate in bud-like tufts at the top of the innovations, not twisted when dry, the youngest bright green, the older dirty yellow, 1.5–2.0 mm. long, 0.60–0.75 mm. wide, carinate concave, ovate- to obovate-lanceolate, the lower shorter, the upper narrower, all

abruptly and shortly acuminate; costa shortly excurrent, or dissolving in or ceasing just below the apex; margin entire or rarely slightly denticulate here and there, slightly revolute or plane, border usually indistinct (when present of one or two rows of narrow cells not thickened); cells rectangular and hyaline below, rhomboidal and densely chlorophyllose above. Flowers polygamous. Seta paler above, flexuous and flattened when dry, not twisted, about 1 cm. long; capsule red-brown or paler, rugose, pendent, oblong-pyriform; operculum small, strongly convex, apiculate, long persistent, not polished; annulus triple, revoluble; teeth of the peristome linear-lanceolate, strongly barred within, .050–.060 mm. wide, .320 mm. long, smooth above, segments of the endostome free, strongly nodose, split between along the keel, cilia two, rudimentary. Spores smooth, .024–.027 mm. diameter.

Crevices in rocks, Funk Island, Newfoundland.

This beautiful species, named for the gentleman who communicated the specimens, differs from its nearest allies in the following particulars:

From *B. pendulum* Schimp. in the longer collum and shorter pointed lid, the free nodose endostome, the short seta, the smaller spores, and the almost immarginate short-pointed imbricate leaves.

From *B. inclinatum* Br. & Sch. in the free nodose endostome, the persistent lid, the short seta, the almost immarginate leaves with less revolute edges and uncolored costa.

From *B. lacustre* Brid. in the long much-branched stems, appressed leaves, shorter seta, slender nearly naked vaginule and polygamous flowers.

Type specimens have been deposited in the herbaria of the National Museum, Harvard University and Columbia College.

6. *Polytrichum piliferum* Schreb. Under spruce, mixed with No. 8, Mingan.

7. *Polytrichum juniperinum* Willd. Mingan.

8. *Polytrichum juniperinum* Willd., var. *strictum* Wallm. (P. strictum Banks.) Mingan and St. Johns, Newfoundland.

Madison, Wis.

BRIEFER ARTICLES.

A few Cape Cod plants.—A two weeks' visit at Hyannisport, in the township of Barnstable, on the south shore of Cape Cod, Mass., in the latter half of August, 1888, revealed to me a most charming flora, a brief mention of which may be of interest. Though it is a ride of but three hours in the cars from Boston, yet the characteristic flowers are very. different, as you are beginning to reach the northern limit of many plants

The country is very flat, covered with a thick growth of Quercus ilicifolia, interspersed, here and there, with Pinus rigida, Quercus alba, and the like, while occasionally is to be seen a dense grove of Pitch Pine which has escaped the woodman's axe. Many acres of the township are devoted to the famous cranberry bogs, and it was a beautiful sight to see the well-kept patches, surrounded and cut by ditches, and so filled with the ripening berries that it was impossible to step upon the beds without, crushing the fruit. One of the commonest wild flowers, at times whitening the fields and even growing by the wheel-tracks in the country roads-was the flat-topped Eupatorium hyssopifolium, which contrasted well with the gorgeous Hibiscus Moscheutos of the swamps, whose large rose-colored corolla was visible at a great distance. Not far from our house was the pond whence originated the pink variety of the Water Lily, Nymphæa odorata, and it was a strange sight to see the water dotted with the pink-red flowers. The pond is jealously protected from invaders.

The most attractive spots, however, for the botanist, were the many little ponds which are so abundant on the Cape. Most of these ponds have a clean, sandy border, and there we found, growing either near the water or in it, Coreopsis rosea, Sabbatia chloroides and stellaris and Lobelia Dortmanna, giving a most beautiful contrast of color to the margin of the pond, while less conspicuous plants were Fuirena squarrosa, var. pumila, Eleocharis olivacea, melanocarpa and Robbinsii, the latter's well-fruited spikes even narrower than the culm, Rhynchospora macrostachya, Scleria reticularis, and other commoner species of the Cyperaceæ. In places on the pond borders Lachnanthes tinctoria was very abundant, as also Xyris Caroliniana, flexuosa, and its var. pumila.

But the great charm of the ponds were the Utricularias. I never saw them in such profusion. In one spot Utricularia cornuta gave the bog a dash of yellow, while Utricularia purpurea was growing and flowering so abundantly that when the sun shone upon it, the surface of the pond was, as it were, painted purple. The pretty little Utricularia inflata was sailing at will on the water, and I found full-fruited plants in large numbers drifted against the shore. Beautiful specimens of Utricularia clandestina were common. This is a very modest plant to see, as its small yellow flower is alone visible above the slimy water which is its favorite home, but when carefully taken up, washed and mounted, it is a joy forever. The clandestine fruit is a prominent feature. At one pond we found what seems to be a very large form of Utricularia gibba. It certainly resembles nothing else, but will require more study. A ditch bordering a cranberry bog was fairly choked with Utricularia minor, but the most careful search revealed no trace of flower or fruit. Perhaps the most interesting find made by my friend (Mr. J. R. Churchill), just after my departure, was Utricularia subulata, var. cleistogama. I saw and determined fresh specimens of it afterwards. It was growing abundantly on the muddy border of a pond in all stages of development, from the early

budding state to the fruiting plant. By dissecting the buds, there was plainly revealed the minute, undeveloped, spurless, purplish corolla, with its two stamens enveloping the pistil. This is its most northern station reported thus far. I have collected the type on the Island of Nantucket.

Of the goldenrods, Solidago odora and ulmifolia were the common ones, during my visit, and the common Aster, in full bloom by September 1st, was the most interesting species Aster polyphyllus. I must not forget to mention the delicate Stachys hyssopifolius, abundant by ponds and along the roadside, and Lycopus sessilifolius, common by ponds, but not reported hitherto from this locality. Though mentioning but a few of the plants collected, I have tried to give some of the characteristic ones, and to show the attractiveness of the place from a botanical point of view. —WALTER DEANE, *Cambridge, Mass.*

EDITORIAL.

IT SEEMS to be the opinion of many that systematic work among phanerogams is an almost finished subject, and that in the great problems relating to histology, physiology, thallophytes, etc., lies the chief work of the future botany. Any one who has worked with phanerogams knows how far from true such a notion is, even when using the old gross characters. But it is still farther from the truth when one comes to consider the relations of histology and embryology to systematic work. These great and comparatively new departments of botany are furnishing data for the systematist, and until the intimate structure and life history of every plant is thoroughly known, the work of systematic botany can not pretend to be more than tentative. It is well known that the gross organs of phanerogams are subject to great variation, variations which are likely to arise in organs which have important work to do, and hence must attempt to adapt themseves to changing conditions. This fact frequently makes specific lines very confusing, and it is just here that histology comes to one's aid. The minuter structures are by no means so sensitive to external conditions as the gross organs, and are more apt to endure the strain of environment unchanged. It is, therefore, a tolerably safe rule that those organs are of greatest use to the systematist which are of least vital importance to the plant, and histology thus often gives us a specific thread upon which to string the widest diversity of gross organs. Contributions to systematic work among phanerogams can be made in no more effective way than by searching their minute structures for characters that will hold. Our ambitious young botanists would be more profitably engaged in doing such work than in magnifying the variations to be discovered in gross organs and insisting hat they should be considered new varieties or species. This work of hunting for variations in flowers, leaves, etc., simply illustrates, what every one already knows, that essential organs will vary.

NOTES AND NEWS.

CELAKOVSKY has lately described a hybrid between *Anthemis Cotula* L. and *Matricaria inodora* L.

DR. DOUGLAS H. CAMPBELL has published[1] his paper onthe germination of the spores of Marsilia Ægyptiaca. The main facts have been already published by him in the *Bulletin* of the Torrey Botanical Club, 1888, p. 258, a paper read before the A. A. A. S.

DR. HENRY L. OSBORN has retired from the editorship of the *American Monthly Microscopical Journal.* The *Journal* will continue under the business management of Mr. Smiley, and will be edited in Washington. Mr. Romyn Hitchcock, the former editor, has lately arrived from Japan.

HANAUSEK has reinvestigated the epidermis of the seeds of Capsicum, and has found that the thin outer wall, which has usually been called a cuticle or cutinized membrane, is mostly cellulose, with a thin inner layer *lignified*, as the very thick inner and side walls are.—*Ber. der deut. bot. Gesells.*, vi. 329.

IT WILL BE remembered that Dr. Gray and J. Hammond Trumbull, in their "Review of DeCandolle's Origin of Cultivated Plants, with Adnotations upon Certain American Species," in the *American Journal of Science* for 1883, contended stoutly for the American origin of two of the three plants of whose nativity DeCandolle was entirely uncertain. These were the garden bean (Phaseolus vulgaris) and squash (Cucurbita moschata). Wittmack has now found prehistoric seeds of Phaseolus vulgaris from North American graves among the collections of the Hemenway expedition to Arizona. Prehistoric seeds of the bean, so far as known to Wittmack, have not before been found in this country. The discovery is of special interest, therefore, as establishing Gray and Trumbull's theories that this land is the home of so important a food. It is to be hoped that a similar confirmation may be given to the evidence regarding the home of the squash.

WE HAVE already commended the *Hepaticæ Americanæ*, issued by Dr. L. M. Underwood and O. F. Cook. Decades I and II of this series of *exsiccatæ*, consisting of representative types of the more common species of the eastern United States, were issued in November, 1887. Decades III and IV, which are now ready for distribution, contain in addition a number of California species, including two never before distributed. The authors announce that at least two decades will be issued annually, if the necessary materials can be obtained; and it is not expected that the number of species to be eventually distributed shall be limited by political boundaries.

Contributions of desirable species are requested, and for every species furnished in sufficient quantity for distribution, a decade of the *exsiccatæ* will be given or some other recompense made.

The price of each issue of two decades is $1.25; they may be obtained of L. M. Underwood, Syracuse, N. Y. Only three sets of Decades I and II now remain.

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[1] Berichte d. deut. bot. Gesells. vi. 340–344, 1 plate.

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Notes on North American Willows. III.

M. S. BEBB.

(WITH PLATE IX.)

THE LANATÆ GROUP.—No more striking contribution to our knowledge of American willows was ever made than when in the Flora Boreali-Americana was published, simultaneously, three new species of this group. Of these, *Salix Richardsonii* would be recognized at the present day as a close geographical equivalent of one of the most beautiful willows of northern Europe;[1] *S. Barrattiana*, differing more widely from the European prototype, is still said to be "equal to it in beauty," with "male catkins two inches long, splendidly silky" (Hooker); while the third, *S. Hookeriana*, if apparently less showy than the other two, is more interesting and unique than either. When we consider the marked character of the species and the prominence given to their publication, each having been accorded a full plate illustration, it is strange that two of the number should remain to the present day known to science only through the old type specimens, while concerning the third, which is common on our west coast, there has since been published only Mr. Nuttall's observations, and quite recently Prof. Sargent's account of its littoral habitat and tree-like size.

Through the generous assistance of friends afield or having access to the great herbaria of the world, I am happily enabled to break the spell of obscurity which has so long hung over this interesting group. Fresh facts concerning *S. Hookeriana* have been brought together; the long lost staminate aments of *S. Richardsonii* have been found, and that, too, among Dr. Richardson's own collections; to this species a new variety is added; and, finally, I have the satisfaction to report the rediscovery of *S. Barrattiana!*

1. S. LANATA L. Eastern British America north of the Arctic circle and Greenland. (Hook. Arc. Pl.) I have not seen specimens.

[1] Wahlenberg says of S. lanata, "Est facile pulcherrima Salix in Suecia ne dicam in mundo toto."

2. S. Richardsonii Hook. Aments closely sessile, thick, very densely flowered; the male ovate-oblong, usually two on each twig, the terminal one larger ($\frac{3}{4}$ in. thick, $1\frac{1}{2}$ in. long), scales dark, rather acute, densely clothed with very long straight ashy-white or pale fulvous silky hairs; female ament terminal, oblong-cylindrical, 2–3 in. long, densely silky with cinereous hairs above and fulvous toward the base; style conspicuously elongated; stigmas linear, entire or 2-parted.

Hab. Fort Franklin on the Mackenzie River, *Richardson* v. s. in herb. Torrey. Repulse Bay, Aug. 22, 1821 (*Parry?*), herb. A. Gray. Crevices of rocks, Nachvak, Coast of Labrador, July, 1885, *Dr. Bell.*

The figure of this plant given in the Flora Boreali-Americana shows a solitary fruiting ament with nearly full-grown leaves on the same twig. This is drawn from "No. 22 Herb. H., B. & T.,"[2] but Dr. Richardson collected other specimens, both male and female, of the same species, earlier in the season, without leaves, and among these in the Torrey herbarium I am astonished to find the staminate aments which have all along been wanting to complete our knowledge of *S. Richardsonii.* The accompanying ticket reads, "7 feet high, erect and spreading; Fort Franklin, Dr. Richardson." The impression has prevailed that the plant was of more humble stature. Andersson says "*frutex parvus*"—probably a mere conjecture, since no mention is made of the height by Hooker. Indeed, as these earlier specimens *are not numbered* I imagine none like them were sent abroad, and hence the incompleteness of the original figure and description and also the omission of Dr. Richardson's field note as to stature.

Var. Macouniana. Leaves orbicular, the earliest obovate, quite entire, less than one inch long and broad, covered when young with floccose hairs, especially on the upper surface, soon smooth, dark green and somewhat shining above, paler and reticulate-veined beneath; aments small for the group, whitish-silky with just a shade of fulvous in the male, scales obtuse, stigmas entire, otherwise as in the type.

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[2] Hooker, Barratt and Torrey, I take it. The willows collected by Richardson, Douglas, Drummond and others were placed in Dr. Barratt's hands to be studied and arranged. He seems to have distributed the specimens into three sets, under corresponding numbers. The most complete set doubtless went to Hooker. The one in the Torrey herbarium is in some respects quite satisfactory, then again provokingly deficient. If Dr. Barratt retained a full set for himself, scarcely a trace of it remained at the time his herbarium came into the possession of Middletown College, so I am informed by Prof. Rice. I am indebted to my friend Dr. Britton for an opportunity to re-examine the interesting old types which fortunately fell to the safe keeping of Dr. Torrey.

South Twin, James Bay. Collected July 17, 1887, by Mr. James M. Macoun, for whom it is named.

"A small, compact bush, 2 to 4 feet high, with just the habit of a garden currant, growing in peaty soil by a small pond in company with *S. arctica*." This association, taken in connection with the resemblance which the leaves bear to certain Canadian forms of *S. arctica*, might suggest the question whether our plant was due to a cross with that species, but the aments do not show a trace of any such admixture. Had it not been for the intermediate character of the Labrador specimens I should have taken this for an extreme modification, either of *S. Richardsonii*, or of the Greenland *S. lanata*, deserving to rank as a good species. Its occurrence on the level of the plain in lat. 53° 20′, further south than any form of either species mentioned has ever been found before, is in keeping with the essentially arctic vegetation by which it is accompanied and the physical conditions described by Mr. Macoun in his interesting "Notes on the Flora of James Bay" (Bot. Gazette, xiii. 113).

Plate IX. *S. Richardsonii* Hook., var. *Macouniana* Bebb. Capsule and stamens ×6.

3. S. Barrattiana Hook. Alpine swamps in the Rocky Mts., *Drummond!* In thickets at high elevations, Kicking-Horse Lake, *Prof. John Macoun!*

When a species of pronounced character is founded upon a single collection and remains thenceforth for more than half a century known to science only through the type specimens, it is interesting to compare the rediscovered plant with the original description and note in how far, if at all, it may be necessary to modify the characters at first assigned. In Prof. Macoun's specimens, the full-grown leaves, 2½ inches long by ¾ inch broad, are elliptic-oblanceolate, pointed at both ends, not at all "blunt and cordate at the base," but with this exception the agreement throughout with the excellent description given by Hooker is perfect, even to the "*stipulis glabriusculis*." This character, omitted by Andersson, would appear to be constant. It presents certainly a striking peculiarity, the like of which I have not observed in any other willow. Set upon a hirsute stem, at the base of silky-pubescent leaves, and thus in marked contrast with the surfaces on either side, we find the stipules yellowish-green and glabrate! The styles and stigmas are reddish-brown. The dark-brown twigs, "marked with the scars of former years' leaves," are rendered still more shaggy in appearance by

the old, blackened, still clinging stipules. The capsules are rather larger than in the type specimens, with the same bifid stigmas; scale narrower.

I can not imagine why Prof. Andersson went out of his way to give as the habitat of this species, "Near Fort Franklin, subarctic America, Richardson, Douglas," for Richardson never collected *S. Barrattiana* anywhere. Douglas never collected anything at Fort Franklin, and finally the credit belonged exclusively to a third person, not mentioned at all, who found the plant in an entirely different locality, a locality confirmed by Macoun's rediscovery.

4. S. HOOKERIANA Barratt. This, as observed by Prof. Sargent, is a small tree 20 to 30 feet in height, with a trunk rarely 12 to 18 inches in diameter, "more often a low straggling shrub with many prostrate stems: on the coast generally along the edge of sea beaches, or in low, rather moist sandy soil." Mr. Howell's experience of the general habit of the species is: "a small tree or large shrub, 10 to 20, or rarely even 30 feet in height, with usually several stems from the same root 4 to 8 inches or more in diameter. It is a plant of the sea coast and salt marshes, usually growing on the margin of ponds, but confined in its range to the immediate proximity of the sea. Very abundant about the mouth of the Columbia, and perhaps the commonest willow of the coast from Port Oxford, near the south line of Oregon, north to Vancouver Island. I have never found it away from the direct influence of the sea. Mr. Nuttall's locality, 'outlet of the Wahlamet,' must be a slip of the pen for outlet of the Oregon (Columbia). I live at the mouth of the Willamette, within a few miles of Wyeth's old station, where Nuttall made his headquarters, and I know that no such tree grows here. I am quite satisfied in my own mind that *S. Hookerania* does not occur inland, though it might possibly be found near a saline spring."

Dr. Barratt describes the capsules as "glaberrimis," and this is emphasized by Hooker's remark, "pistil perfectly glabrous, even its stipe;" but while true of the type specimens (the capsules of which are past maturity), I find that more frequently the capsules, especially when young, are silky. This is quite noticeable in a form collected by Prof. Macoun on Vancouver Island, and goes to confirm the seeming affinity with *S. Barrattiana*. Furthermore, mixed with the type specimens of *S. Barrattiana*, coll. *Douglas*, are pistillate aments without leaves, but showing shorter stigmas *invaria-*

bly entire, shorter style and longer pedicel—a manifest variation in the direction of *S. Hookeriana*. We are thus led to recognize as between *S. Hookeriana* of the Pacific coast and *S. Barrattiana* of the Rocky Mountains a relationship similar to that which prevails as between *S. lasiolepis* and *S. irrorata*, *S. lasiandra* and *S. Fendleriana*, *S. Scouleriana* and *S. flavescens*, only that both in habitat and character the difference is more pronounced. for in no one of the parallel cases mentioned is the coast plant confined to the immediate sea shore.

In the Flora Boreali-Americana two widely sundered localities are given for this species, viz.; "Grand Rapids of the Saskatchawan, *Douglas*. N. W. coast of America, *Scouler*." Writing while all the facts were fresh, Hooker seems to have known that the plant had been collected by Scouler on the N. W. coast, but there are no specimens credited to Scouler in the Hookerian herbarium. "There is only one sheet of *S. Hookeriana*, and on it are the analyses which indicatethat from this the plate in the Flora Boreali-Americana was drawn. To it is attached a label in the handwriting of Douglas, 'Near the Grand Rapids of the Saskatchawan, rare—a scrubby, low shrub'" (Baker). The plant figured is identical with that now so well known from all along our northwestern coast. I believe the specimens were collected by Scouler, and that the Douglas ticket, carrying with it the Saskatchawan habitat, was misplaced by Dr. Barratt. The very wording of the ticket, "A scrubby low bush," is inconsistent with the distant nodes and smooth vigorous shoots of the figure; but, above all, it is incredible that a tree which by the concurrent testimony of all recent observers is known only as growing on the beach or around the brackish ponds of the Pacific coast, should, "once upon a time," half a century ago, have been found east of all the Rockies and thenceforth escape detection by all subsequent explorers. Beyond this negative evidence, which could scarcely be stronger than it is, there lies another consideration not to be lost sight of. When two species, representative each of the other, are found occupying areas separated by physical features which would appear sufficient to cut off all interchange, one becoming modified by and restricted to a humid coast environment, the other modified by and restricted to a high mountain environment, it is absurd to expect that one will be found invading the area of the other and preserving intact its specific identity.

For my own part, I know too well how prone Dr. Bar-

ratt was to be just a bit careless, to say the least, in arranging loose material, to believe implicitly that the Douglas ticket was rightly placed, against such cumulative evidence to the contrary.

Rockford, Ill.

Intracellular Pangenesis.

DR. J. W. MOLL.

This is the title of a book by Prof. Hugo de Vries, which has just appeared in the German language.[1] and will no doubt create considerable interest. The subject with which it deals is one of the highest importance, and of the manner in which it has been treated I will try to give a short account.

By many investigators of organized nature, and especially by those who have studied the phenomena of heredity, the necessity has been felt of assuming that hereditary characters in animals and plants are the visible effects produced by the nature of those substances which constitute living organisms. Hence many speculations have arisen about the structure which these substances may possess, and about the manner of their dispersion through the living body. However hopeless such attempts to penetrate into one of the greatest mysteries of nature may at first sight appear, some light certainly has been thrown on this matter through the exertions of several distinguished naturalists.

Among these Charles Darwin, without doubt, ought to be named in the very first place, and the chief object of this book is to induce in its readers a more just and higher appreciation of one of the most fertile conceptions of this illustrious author.

But others have studied the same subject, and of these the principal are Herbert Spencer, Haeckel, Nägeli, and Weismann. A comparative and critical consideration of the different views to which the above named authors have been led is the subject of the first part of Prof. de Vries's book.

In the first place, he ably shows that Darwin's so-called provisional hypothesis of pangenesis[2] essentially consists of two well defined and in many respects independent parts:

1. All hereditary characters of an organism are repre-

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[1] Jena, Gustav Fischer, 1889.

[2] The Variation of Animals and Plants under Domestication. Vol. ii. p. 349.

sented by separate particles of living matter. Of these there are as many kinds as there are characters, and Darwin has called them "gemmules." Their principal attributes are that they are capable of growth and reproduce themselves, and that they can remain latent for a long time, even during many generations. In this case the hereditary characters with which they correspond do not become visible, but after a certain time they may reappear. When cell-division takes place, the gemmules are equally divided in the two nascent cells, and this is one mode of migration, by which the several organs and tissues of the body acquire their hereditary characters.

2. There is still another mode of migration, as it is assumed that every separate part of the whole organization throws off its gemmules, which are dispersed throughout the whole system, and are collected from all parts to constitute the sexual elements and buds, from which new beings are developed.

The second position was much insisted upon by Darwin, as he thought this assumption necessary to explain the hereditary effects of use and disuse, the occurrence of graft-hybrids, and the direct action of the male element on the female.

Our views upon this part of the subject have been much changed since Weismann[3] has shown that those cases in which characters, seemingly acquired in later life, are transmitted to the offspring, do not necessarily prove a transmission of these characters from the altered organs to the germ which will become a new individual. They can be explained as well by assuming that the peculiar structure of the germ, from which the first varying individual sprung, caused the subsequent variations also, and that they were thus transmitted from germ to germ.

Hence there remain only a few, seldom occurring cases, which seem to be inexplicable, if migration of gemmules is not conceded. But as some of these cases can be explained otherwise, and all stand in need of further investigation, there are now no sufficient reasons to support the theory that gemmules migrate from all parts of the organism in order to unite in some other parts.

Those authors, however, who are opposed to the migration theory, have mostly thought that with it the whole hypothesis of pangenesis fell. But this, obviously, is a grave error, as the first and essential supposition of the hypothesis remains unshaken by these arguments.

[3] Ueber die Vererbung, 1883.

On the single assumption that there exist "gemmules," in Darwin's sense of the word, and that these are transmitted by cell-division through all parts of the system, it still remains possible "to connect under one point of view several grand classes of facts," of which the principal are: all forms of asexual and sexual reproduction, heredity, variability, reversion, regrowth of amputated parts, and development of organisms in all its forms, whether normal or abnormal.

Darwin's pangenesis, notwithstanding its usefulness and simplicity, has been exposed to many misunderstandings, and this may partly be attributed to the great stress laid by its author upon the migration of gemmules; partly also to the fact that the term "gemmules" itself was not happily chosen. It has certainly been misinterpreted by some authors in the most unaccountable manner, and as, moreover, the idea of wandering particles is closely connected with it, de Vries does not use this term. The particles, to which the development of hereditary characters is due and which, according to his view, do not migrate through the whole organism, are called by him "pangens" (Pangene). Though this word, as well as that of pangenesis itself, will, without doubt make the hairs of a strictly grammatical reader stand on end, we will adopt it without scruple, because it is short and expressive. Moreover, its illegitimate origin will guard it against being misunderstood, as the term gemmules was.

Besides Darwin, as I have already observed, others have at one time and another tried to solve the same problem, and we will follow de Vries in his discussion of these several hypotheses.

That of Elsberg-Haeckel is especially characterized by the view that the material basis of heredity is to be sought for in the chemical molecules which constitute living protoplasm. Now it is certain that in the end the laws of heredity will be explained by the molecular phenomena of living beings. But as yet we are still very far from this point, and we are forced to assume that the particles of substance to which the appearance of hereditary characters is due, are capable of assimilating food, of growing and of reproducing themselves. There is no theory in existence which can explain from a purely chemical point of view, and merely by making use of the known properties of chemical molecules, these wonderful phenomena. Thus we are led to believe that if hereditary characters are bound to certain substances, the molecules of these substances are united into particles of

a much higher order, and approaching in their complexity of structure, power of growth, and self-division, the lowest organisms themselves. This has already been pointed out by Darwin, and if this be conceded, it obviously follows that these particles are not identical with chemical molecules in the proper sense of the word. The truth of this has perhaps in some measure been felt by Elsberg and Haeckel when they gave to the molecules, which represent hereditary characters, the distinctive name of "plastidules."

Some other authors, in particular Spencer and Weismann, have avoided this fault, but they do not assume, with Darwin, that every separate hereditary character of each organism is represented by a separate kind of living particles. They, on the contrary, suppose that the living matter from which an organism is developed consists of indivisible particles, each representing all hereditary characters of the species to which it belongs. It is certainly of much importance that de Vries has clearly pointed out the existence of this difference, as it will lead to a better understanding.

Spencer has called these particles "physiological units;" Weismann has given them the name of "ancestral plasmata" (Ahnen-plasmen), and he has applied his views to the more recent discoveries in cellular morphology. He is of opinion that the ancestral plasmata have their seat in the nucleus of the cell.

Though in many respects differing from the foregoing hypotheses, still Nägeli's "idioplasma" also represents all characters of the species.

This is a common feature of all these hypotheses, and their most important distinction from Darwin's pangenesis, as here it is assumed that every organism contains multitudes of different pangens, each representing a separate hereditary character, or as Darwin himself has expressed it: "an organic being is a microcosm—a little universe, formed of a host of self-propagating organisms, inconceivably minute and numerous as the stars in heaven."

The question, which of these opposed views is nearest to the truth, is amply discussed by the author, and almost the whole first part of the book is devoted to it.

First it is shown that the different and numerous hereditary characters which a species displays are in many respects independent of each other. To those who believe in the origin of species by means of natural selection, it is obvious

that the several characters, now constituting together a certain species, can not have appeared all at once, but were gained step by step, in many instances, without doubt, one by one.

The same characters often occur in many widely different species, *e. g.* the power of forming chlorophyll, tannin and many other substances, the peculiar habits of climbing and insectivorous plants, etc. All these are essentially the same in different plants, often belonging to separate families and orders.

It also often occurs that a single character, for instance hairiness or a certain coloring matter, is missing in a species, which otherwise exhibits in all its parts the same characters as other species of the same genus.

The differences between several species, and those between the several organs of a single animal or plant, are quite of the same order. This is conclusively shown by those cases in which secondary sexual characters or the different forms occurring in alternate generation furnished a foundation for many species, now recognized as the male, female or asexual forms of other species.

In many instances, also, simple bud-variations in plants have been developed by the art of man into new varieties of plants. And, lastly, it is generally known that the same peculiarities, for instance a red cell-sap, may be characteristic as well for certain species of a genus as for certain organs of a single individual.

Nobody will dispute the fact that many hereditary characters can be altered, or even can disappear, in some individuals, without other characters of the species in the same individual being in the least degree affected. An individual plant may have no hairs, or exhibit a changed color, all its other characters remaining the same as those of its parents; though it must be borne in mind that often little groups of characters are known to vary together. Breeders of animals and plants daily make use of such occurrences for improving their breed, and probably the scientific investigation of such cases will throw much light upon the nature of hereditary characters.

The cases of reversion, for instance that of stripes in horses and asses, show that often characters which belonged to far progenitors may suddenly reappear and combine with other characters which remain unaltered.

Another important fact is this, that hereditary characters

may be blended together in the same individual, even if they originally belonged to different species. This is most clearly shown by the occurrence of hybrids, which generally hold an intermediate place between the father and mother. But even in this case the characters retain their independence, as is clearly shown when these hybrids are fertile *inter se*. For in the subsequent generation generally some individuals wholly revert to the shape of their grandmother, others to that of their grandfather, and all intermediate gradations may be observed. In normal sexual reproduction in general the same rules prevail. All the foregoing facts, of which I am only able to give a brief summary, point to the conclusion that every character is bound to its own kind of material particles, and that these are in many respects independent of each other. On the other hand, it will be very difficult, if not impossible, to reconcile with these facts the view that in living beings all hereditary characters of the species are represented together by one and the same kind of indivisible particles. At all events this view is a wholly superfluous auxiliary hypothesis.

But there is more. When the different organs of the body are formed and developed, the characters of these organs gradually appear, and thus some parts become different from others. In pangenesis this offers no difficulty, as it is not inconceivable that some pangens are developed in one, some in another part of the body. But if the opposite assumption is made, we here meet with many obstacles. This subject has been discussed by Weismann, and he has been forced to the supposition that there are two strictly separate kinds of protoplasm, one of which he has called "germ-plasma" (Keimplasma), the other "somatic plasma" (somatisches Plasma). The first of these consists of his "ancestral plasmata," and can reproduce the whole organism. Somatic plasma is developed from germ-plasma, when the vegetative organs of the body appear. It is less complex in structure, and contains only those characters which are needful for the parts to be formed.

In the higher orders of animals it may seem in some degree possible that two such kinds of protoplasm should exist, but every botanist will grant that in plants there is an overwhelming evidence against the supposition that the protoplasts of leaves and roots are widely different from those of spores and seeds. Many are the cases in which well-defined vegetative organs and even all cells of highly complex plants

can form the basis of a new being. The productions of gall-insects show in the same manner that in every part of a plant many hereditary characters lie hidden, which will only appear if a proper stimulant is applied. Thus the hypothesis of germ- and somatic-plasma, though it may have a logical foundation in Weismann's assumption of ancestral plasmata, is not at all supported by the facts observed in nature. And from this point of view it certainly is a great advantage that pangenesis has nothing whatever to do with such a secondary hypothesis.

Lastly, Spencer and Weismann both admit that when sexual propagation takes place, the physiological units or ancestral plasmata of father and mother are both to be found in the offspring. And this would lead to the assumption that in every organism all its ancestors from the beginning of organic life till the present day are represented. Both naturalists have felt the absurdity of such a proposition, and both are compelled to a new auxiliary hypothesis; Spencer supposing that diss milar physiological units, when mixed together, tend to segregate, and Weismann taking for granted that each time, before a sexual union takes place, one-half of the ancestral plasmata are first removed, so that their number remains constant. This removal, according to Weismann, takes place when the second polar-globule is expelled from the ovum.

Pangenesis, again, has no need whatever of such an assumption, as no reason can be given why an excessive number of different pangens should associate.

From all these considerations it may be concluded with safety that pangenesis, combining all advantages of its sister-hypotheses, greatly excels them, so that it has no need of any auxiliary hypothesis whatever.

It is, moreover, much more simple in its application. Apparently this is not the case, as pangenesis assumes the existence of great numbers of different pangens in every being, whilst of ancestral plasmata or physiological units one kind suffices for the formation of the most complex organism. If, however, not a single being, but all organisms which the world contains are considered, the case is entirely reversed. Then it must be conceded that one is compelled to assume as many different kinds of physiological units or ancestral plasmata as there are and ever have been species in the world. In pangenesis, however, a relatively small number of different pangens will suffice to form by its numberless combina-

tions and permutations all living and extinct organized creatures.

It is a curious fact that Darwin himself has not laid much stress on the peculiarity of his gemmules as not representing each the whole organism, but only a single or a few hereditary characters. But he thought that this proposition was evident to all those who had studied the subject. He even thought, for a time, that his views were materially the same with those of Spencer, who wrote some years before him, although he afterwards saw that this was not the case.

Perhaps to this circumstance, also, it may be partly attributed that the hypothesis of pangenesis has as yet found few adherents among leading naturalists. But now this obstacle has been removed. The name of gemmules, which caused so many misunderstandings, is replaced by another. Last, but not least, Prof. de Vries has clearly shown that on no other known assumption can many important classes of facts be connected together so well as on that which forms the basis of pangenesis. I have no doubt that for this hypothesis a new era begins with the publication of this book.

In the second part of his book the author deals with the more recent discoveries in cellular morphology. He shows that the hypothesis of pangenesis, as set forth in the first part, is in perfect accordance with what has been brought to light for the most part long after Darwin had written his hypothesis. It is only natural that in applying it to the microscopical structure of cells some questions arise. These have been answered by the author, and thus some additional propositions are made, which, together with the original hypothesis, constitute what the author has called "intracellular pangenesis."

This second part of the book is much longer than the first, but it is impossible, in so short a compass as is allowed here, to mention many details, which are, however, necessary for fairly reproducing it. I must be content with giving only some faint outlines, which perhaps will induce the reader to peruse the book itself.

In the first place, it must be remembered that Prof. de Vries, in one of his former publications,[4] has explained his views on the structure of the protoplasmic body of vegetable cells. With Hanstein, he considers the protoplasmic contents of every cell as an individual, and, with this author, he gives to it the name of "protoplast." He is opposed to

[4] Plasmolytische Studien. Pringsh. Jahrb. xvi. p. 489.

those who consider the protoplasm as a gelatinous mass, in which here and there some bodies, such as a nucleus and plastids, are imbedded, and he calls the protoplast an elementary organism, composed of several organs, which stand in some respects in the same relation to each other as the organs of a multicellular plant. There is, however, one peculiarity in the organization of the protoplast, which is that its organs always derive their origin from similar organs. As far as is now known, they never appear in a protoplast which has not received them from its ancestors, and if a protoplast afterwards contains more organs of the same sort than it did when young, these are formed by repeated divisions. It may be said, with perfect truth, that the organization of protoplasts is a visibly hereditary one.

These views, of which I can only give a very short account, are discussed here in detail, as recent discoveries, partially made under the auspices of Prof. de Vries himself, have contributed much to confirm them. As for the nucleus, it is now generally known that this must be a very important organ, that it propagates itself by division, and never appears except where this has taken place. The same has been proved for plastids by Schmitz, Schimper and Arthur Meyer.

By Prof. de Vries himself it has been shown that vacuoles have a wall of living protoplasm, which can easily be separated from the other parts of the protoplast. He has called this wall "tonoplast," and has conclusively shown that it must be considered also as a separate organ, in all probability for producing cell-sap. Now the question remained, whence did the protoplast derive its tonoplasts and vacuoles, and this has been solved by Went, who has found that all vegetable cells, even the very youngest, contain vacuoles; that they can divide themselves or be divided, and thus multiply; and that in those cases in which formerly the appearance of vacuoles in homogeneous protoplasm was assumed, they are already present, but have been hitherto overlooked.

Another of Prof. de Vries's pupils, Wakker, has found that the so-called aleurone-grains are nothing else than the dried up albuminous contents of vacuoles in seeds, and that crystals in living cells are formed within the vacuoles.

Thus the whole protoplast appears as an organized individual, with its nucleus, plastids (which in many cases form starch), and tonoplasts (always containing cell-sap, often crystals or aleurone-grains). In the remaining part of the

protoplast a homogeneous superficial layer, which probably produces the cell-wall, can be distinguished from the inner granular mass, which is almost always in motion. It is in accordance with the author's views to see in these two parts, also, peculiar organs of the protoplast, and to suppose that the one can not be formed out of the other. He elaborately shows that, for the present, there are no facts proving such a transition, and that this subject deserves being thoroughly investigated.

At all events there is ample evidence to prove that the protoplast is an elementary organism, possessed of an hereditary organization. When cell division takes place, each daughter-cell receives its several organs as such from its parent cell, and there are no cases on record in which these organs have been independently formed from a homogeneous protoplasmic mass.

This conception of cell-division is called by the author the "panmeristic" view, in opposition to the old "neogenetic" view, which supposed that the organs of the protoplast could be newly formed after the cell is divided. As far as nucleus and plastids are concerned the neogenetic view has already been abandoned by most authors.

In the second place, the progress in our knowledge of the process of fecundation is amply discussed. It is shown that, according to the latest discoveries, it is the union of two nuclei which chiefly characterizes this process.

In the conjugation of algæ only the nuclei penetrate each other. The same is the case when a properly so-called fecundation takes place, in spermatozoa and pollen-grains the nucleus only penetrating into the ovum and uniting with its nucleus.

From these facts it appears that after fecundation in the higher organized plants the germ-cell, in truth, only contains a fecundated nucleus, whilst all other hereditary organs of its protoplast are derived only from the mother-plant.

The author applies these several facts and views to the hypothesis of pangenesis. In explaining this we will, for convenience, suppose that the pollen of one species fecundates the ovum of another allied species, and that in this manner a hybrid is formed which, as usual, in all its charactersis midway between the parent plants. Common sexual reproduction is essentially the same process, and therefore the conclusions to which we come in this manner are applicable to all other cases.

As a single nucleus has sufficed for fecundation, it is clear that, on the basis of pangenesis, this must have contained pangens, representing all hereditary characters belonging to the father-plant. But all organs of the hybrid are hybridized (plastids, vacuoles, etc.), and hence it follows that the hybrid nucleus can influence in some manner all other organs of its protoplast, and thus all hereditary characters of the species.

Now the question remains, how it is possible that the nucleus exercises such an influence. Various answers can be given. Some authors maintain that a certain dynamic influence is transmitted from the nucleus to all other parts of the living protoplast; others propose the doctrine that certain enzymatic substances emanate from the nucleus and can produce changes in the surrounding protoplasm. On both these suppositions (and if it be conceded that the nucleus contains all sorts of pangens) it must be assumed that in all other organs of the protoplast there are peculiar substances, capable of growth and propagation, and producing through the dynamic or enzymatic influence from the nucleus those visible effects of which the pangens are the representatives. For, as has been shown, tonoplasts, plastids, etc., can propagate their kind, and it is through the activity of these organs of the protoplasts that hereditary characters become manifest. It is obvious that here is a secondary hypothesis of which there is no need. For if it is assumed, with Darwin, that not only the nucleus, but all other organs of the protoplast, in short living protoplasm in the widest sense of the word, consists of pangens, and of these only, the hypothesis of two kinds of self-propagating particles, corresponding with hereditary characters, becomes gratuitous. And at the same time, the supposition of a dynamic or enzymatic influence, issuing from the nucleus, can on this view be dismissed, whilst in its place comes the much simpler suggestion that pangens can migrate from the nucleus to all other organs of the same protoplast, of which it forms the center.

Our present views on the origin of species independently lead to the same conclusion, as it is clear that in the first organisms without nucleus, pangens were diffused throughout the whole protoplast, and were afterwards combined in one body when a nucleus made its appearance.

The hypothesis, explained in the foregoing lines, is called by Prof. de Vries that of "intracellular pangenesis." Giv-

ing a brief recapitulation, it can be said to consist of the following assumptions: The nucleus of every cell, used in propagation, contains all sorts of pangens of the species of animal or plant to which it belongs. As all other nuclei of the full-grown being owe their origin to repeated divisions of the first one, they all can be in possession of a complete set of pangens, which can propagate themselves when a division iakes place. In the nucleus the greatest part of them remain tnactive through life, with the exception only of those pangens which determine the visible characters of the nucleus itself, such as its peculiar mode of division, etc.

All other organs of the protoplast essentially contain only pangens corresponding to the characters which they are capable of displaying. It is, however, by no means necessary that they all are at all times in an active state, as, for instance, plastids in some cases are known to exhibit alternately their power of forming starch and that of forming colored matter. But, no doubt, at most times these organs contain a large amount of active pangens.

Inactive pangens from the nucleus can migrate to those other organs of the protoplast, whose characters they represent; they can again propagate themselves here, and in most cases sooner or later become active, thus bringing to light certain characters.

This migration, as shown by the facts of sexual reproduction, must occur soon after fecundation has taken place, but there is no reason why it could not happen in many other phases of development, perhaps even every time a cell-division is achieved. The author is of opinion that the migration of pangens from the nucleus to other parts oı the protoplast may be effected by the movements of protoplasm, to which view there is the less objection as it has been lately shown that these movements are by no means wanting, even in the very youngest vegetable cells.

From the foregoing review it is obvious that on the assumption of intracellular pangenesis the possibility of pangens migrating from one part of the body into other parts is not at all excluded. This will be readily assented to if it is recollected that of late years many facts have been accumulated proving that the protoplasts of neighboring cells are connected together by fine protoplasmic filaments passing through the cell-walls. Moreover, Prof. de Vries himself has rendered it highly probable that the movements of pro-

toplasm are the means by which alimentary and other substances are transported through the vegetable body.

But it must be borne in mind that if the possibility of a migration of pangens from cell to cell be conceded from an anatomical point of view, this by no means suffices for the assumption that it actually does take place. And as Weismann has shown that there are no facts in heredity imperatively requiring such an explanation, a migration of pangens through the whole body is excluded from the hypothesis of intracellular pangenesis.

Moreover, in confining the migration of pangens within the limits of a single protoplast, there is only assumed that inactive pangens can leave the nucleus and sooner or later become active in other parts of the protoplast. But if the assumption of free migration through the whole body shall have any connection with the facts of heredity, a further hypothesis is necessary, viz.: that pangens, coming from all parts, are able to enter into the nuclei of those cells, which will serve for propagation. But, as has been shown, this hypothesis can be dispensed with.

It would, of course, be a delusive fancy to think that on so complex a subject as that which has been so ably treated by Prof. de Vries, the greater part of scientific men will at once, or even at a not very distant period, become of the same mind; and he himself is probably well aware that some of his propositions will be vigorously attacked. Moreover, he has chiefly treated his subject from a botanical point of view, and in a few cases, perhaps, there will be some difficulty in applying his hypothesis to the animal organism. But there is a great probability that such difficulties will not prove to be permanent ones.

At all events, even those most opposed to his views will be forced to acknowledge that intracellular pangenesis has been expounded by one who has fully mastered his subject, and that it certainly deserves to be carefully considered in all its parts, be the conclusion to which such consideration leads what it may.

It is from this conviction that I have not thought it useless to give a short account of Prof. de Vries's book to the readers of this journal.

Utrecht, Holland.

Fibres and raphides in fruit of Monstera.

W. S. WINDLE.

(WITH PLATE X.)

Monstera deliciosa is a native of Central and South America, belonging to the Aroideæ, and closely related to the Calla. It possesses a weak, elongated, stoloniferous stem, by which it clings to rough walls, or rocks, or firmly clutches some tree by means of its numerous adventitious roots, reaching sometimes 10 to 50 feet in length or more. Its large, wide-spreading leaves, borne upon long petioles, are perforated by large elongated openings. The cylindrical fruit is an aggregate, termed by Dr. Masters a berry or sarcocarp. It is borne erect upon a long, rounded peduncle among the upper leaves of the plant, and when young is sheathed by a hood-like deciduous spathe. The fruit when mature is about 20 cm. in length by 4 cm. in diameter. Running through its center is a thick core (endocarp), surrounding which is the pulpy, edible portion. This latter part is composed of small, elongated, hexagonal segments placed side by side. Each is made up of a thick inner part (mesocarp), and of a thinner outer part (exocarp). These separate from each other in the ripened fruit. The mesocarp is the true edible portion of the fruit, and is considered by many as a great delicacy because of its pleasant characteristic flavor, slightly resembling that of the pine-apple. But the outer part of the fruit, the exocarp, is always judiciously discarded, on account of the sharp, stinging sensation produced upon the tongue and palate when it is taken into the mouth, an effect similar to that caused by weak acids.

By placing a minute part of this exocarp under the microscope, the cause of this peculiar action is at once shown. Groups of slender, sharp-pointed, needle-like cells or fibres appear half embedded in the large-celled parenchyma tissue. Careful observation brings to view a second set of needle-shaped objects, very minute, which from their regularity in shape and size may at once be recognized as crystals or raphides.

To ascertain the true nature of these raphides and fibres, chemical tests were applied, as directed by Strasburger, Goodale and de Bary, with the following results:

Acetic acid has no perceptible effect upon either form,

while hydrochloric acid dissolves the raphides without effervescence, proving them to be calcium oxalate. The fibres are proven to be lignified from their reactions with phloroglucin and hydrochloric acid, also with aniline sulphate and sulphuric acid. Treated with iodine and sulphuric acid a reddish-yellow color is produced, which confirms the above statement. Knowing that these fibres are hard-walled, lignified cells, and that they appear scattered through the parenchyma, they may therefore be placed among the sclerenchymatous tissues. Similar cells to the above, occurring in Aroideæ, Rhizophoraceæ, Nymphæaceæ, and especially those found in the leaf lamina of Monsterineæ, are termed "internal hairs" by de Bary. Concerning them he says:[1] "Numerous hairs are contained in the cavities and passages of the lamellar parenchyma. * * * * They closely resemble sclerenchymatous fibres and were therefore first described as 'bast cells' by Schleiden." Farther on he makes the statement that hard-walled hairs are fundamentally related to sclerenchymatous fibres in every respect and are special cases of the latter, distinguished by form and distribution.

On taking longitudinal sections from various parts of the plant, the fibres are found to occur in every part. But in no part are they found in so great numbers nor so perfectly developed as in the exocarp or outer portion of the fruit. Here they resemble true bast fibres, with but little branching, while in the leaf lamina and spathe, especially, they are very slender and variously branched, filling the interstices of the surrounding tissue and resembling the "internal hairs" described by de Bary.

For a general description of the fibres it may be stated that the walls are very evenly thickened, possessing no projections nor characteristic markings. They are firm in texture but not brittle as wood fibres. In length they are from .9 mm. to 1.6 mm.; in diameter from .015 mm. to .03 mm. Their contents are similar to those of the surrounding cells, but slightly granular. They occur in the parenchymatous tissue situated in the interstitial or intercellular spaces.

While the fibres differ much in size and assume a variety of shapes, due mainly to their promiscuous branching, we find the raphides to be of nearly uniform size and form. Like the fibres they occur throughout the plant in the parenchymatous tissue, but most abundantly in the fruit. Here

[1] Comp. Anat. of Phanerogams and Ferns.

they occur in countless numbers. Lying parallel with one another, they form compact bundles which are situated in narrow elongated cells, known as crystal cells. The raphides are very minute; in length from .01 mm. to .012 mm.; in diameter about .002 mm. They are many sided, with angles and faces poorly defined, and possess sharp ragged ends. In addition to raphides, isolated stellate crystals are also found in the fruit of Monstera.

Concerning the early developement of fibres, de Bary states that they arise by early outgrowth of a cell of the wall of the cavity (usually one layer of cells thick), which remains relatively narrow so as to form long, pointed arms. This explanation may be accepted as general, but it has not been satisfactorily proven in this special plant.

Finally, we may draw the conclusion that since the raphides are so minute, and form such a small quantity compared with the fibres, and since the action of calcium oxalate is very slight, the peculiar sensation caused by placing a piece of the outer fruit in the mouth must necessarily originate from the mechanical action of the sharp-pointed sclerenchymatous fibres, and not from any chemical action of the raphides.

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EXPLANATION OF PLATE X.—Fig 1. Fruit of Monstera deliciosa. Fig. 2. Section of fruit showing structure; *a*, endocarp or core; *b*, hexagonal segments or fruit proper; *x*, mesocarp or edible portion; *y*, exocarp. Fig. 3. Exocarp dissected under low power; *a*, fibers, *b*, raphides. Fig. 4. Fiber and raphides under high power. Fig. 5. Cross-section of "fruit proper;" *a*, cross-section of fibre. Fig. 6. Longitudinal section of "fruit proper;" *a*, crystal cell; *b*, parenchyma cell; *c*, fibre.

Our worst weeds.

BYRON D. HALSTED.

It is due to those who have already aided me in the study of the weed flora of the United States that some preliminary report be given. The first twenty-five lists which have been received contain in all 267 species, and represent 14 states, ranging from Massachusetts to California, and Wisconsin to Texas. As, in the present article, we are to deal with the worst weeds, attention will be confined to those which appeared at least five times in the lists. Of these there are 34 species, which will be enumerated below.

To those who may not have chanced to see the kind note of the editors of the GAZETTE (xiii. 327), setting forth my wishes, it may be said that the call was for at least the twenty worst weeds in any locality or territory which any one would be pleased to report upon. In nearly all instances the weeds were given their rank as to injuriousness, and from such reports the present article is made up. Following each species will be observed a fraction: the numerator indicates the number of times the species appears in the twenty-five lists, while the denominator is the sum of all the rank numbers. Thus, Agropyrum repens has the fraction $\frac{8}{31}$, which indicates that this "quack-grass" or "quick-grass" appears eight times in the twenty-five lists, and that the rank total is thirty-one, the respective ranks being 5, 1, 4, 3, 9, 2, 5, and 2. As another illustration, Chrysanthemum Leucanthemum, or "ox-eye," "ox-eye daisy," or "bull's-eye," also has eight mentions, but the sum of the rank figures, 4, 16, 17, 9, 5, 11, 6, 12, is eighty. It will be seen that the fraction following each species therefore indicates the rank of the injuriousness of each sort, as far as averages can do it in connection with the wide or limited distribution of the species. The thirty-four are as follows, arranged alphabetically:

Agropyrum repens, $\frac{8}{31}$.
Amarantus albus, $\frac{5}{75}$.
Amarantus retroflexus, $\frac{12}{107}$.
Amarantus spinosus, $\frac{5}{64}$.
Ambrosia artemesiæfolia, $\frac{17}{109}$.
Ambrosia trifida, $\frac{8}{72}$.
Arctium Lappa, $\frac{12}{157}$.
Asclepias Cornuti, $\frac{5}{43}$.
Bidens frondosa, $\frac{6}{77}$.
Brassica Sinapistrum, $\frac{5}{62}$.
Capsella Bursa-pastoris, $\frac{11}{138}$.
Cenchrus tribuloides, $\frac{8}{52}$.
Chenopodium album, $\frac{16}{155}$.
Chrysanthemum Leucanthemum, $\frac{8}{80}$.
Convolvulus sepium, $\frac{7}{87}$.
Cnicus arvensis, $\frac{7}{16}$.
Cnicus lanceolatus, $\frac{6}{78}$.
Datura Stramonium, $\frac{6}{76}$.
Erigeron annuum, $\frac{5}{50}$.
Hypericum perforatum, $\frac{5}{70}$.
Panicum Crus-galli, $\frac{6}{71}$.
Panicum sanguinale, $\frac{11}{75}$.
Portulaca oleracea, $\frac{20}{201}$.
Rumex Acetosella, $\frac{11}{91}$.
Rumex crispus, $\frac{14}{149}$.
Rumex obtusifolius, $\frac{5}{56}$.
Setaria glauca, $\frac{8}{73}$.
Setaria viridis, $\frac{5}{27}$.
Solanum Carolinense, $\frac{5}{39}$.
Solanum rostratum, $\frac{5}{47}$.
Taraxacum officinale, $\frac{5}{68}$.
Vernonia fasciculata, $\frac{6}{90}$.
Xanthium Canadense, $\frac{8}{48}$.
Xanthium stramonium, $\frac{8}{58}$.

The numerators may fairly indicate the prevalence of the weed. Thus Portulaca oleracea, the common purslane or "pusley," has the most frequent mention, namely, 20 out of the 25; while Solanum rostratum, the Texan nettle or beaked horse-nettle, is only five times reported in the list,

but is a vile pest moving northward and eastward, and if not checked in its course will bring dismay to thousands of farmers who now know nothing of its pernicious habits.

The interested reader can quickly select from the table the species which are most prevalent over the whole United States, but the relative injuriousness, which is obtained by dividing the denominator by the numerator, is not so easily seen. The following list of 20 is therefore given in the order of injuriousness, beginning with the worst:

Cnicus arvensis.	Setaria glauca.
Agropyrum repens.	Chenopodium album.
Xanthium Canadense.	Chrysanthemum Leucanthemum.
Cenchrus tribuloides.	Portulaca oleracea.
Panicum sanguinale.	Rumex crispus.
Ambrosia artemisiæfolia.	Panicum Crus-galli.
Xanthium stramonium.	Convolvulus sepium.
Rumex Acetosella.	Capsella Bursa-pastoris.
Amarantus retroflexus.	Cnicus lanceolatus.
Ambrosia trifida.	Arctium Lappa.

The writer is anxious to add to the number of his reports, and will be pleased to hear not only from every state and territory in the Union, but in such numbers that the summary derived from them may furnish a basis for future calculations, if not for national legislation. Questions of eradication, quarantine and the like, come naturally after the nature of the pests has been settled upon in the broadest sense. The greater part of this work must be done by local observers who are willing to aid in arming ourselves as a nation against a vast array of active enemies to American agriculture. If any one will add to or take from the list of 34 species herein given, let him do so as a bit of public service.

New Brunswick, N. J.

Sweet Cassava (Jatropha Manihot.)

H. W. WILEY.

About the middle of March, last year, I received from Mr. R. H. Burr, of Bartow, Fla., a package of cassava roots. These roots reached the department in fine condition, being apparently as fresh as the day they were taken

from the soil. After careful sampling and cleaning a sufficient quantity of the roots was cut into thin slices and thoroughly dried. In a definite weighed portion, sampled as carefully as possible, the percentage of moisture was determined. The dried and powdered roots were preserved for future analysis. Owing to a press of other matter this analysis was not made until the latter part of July and the first of August, 1888. Mr. Burr, in forwarding the roots, sent the following information concerning them:

"The roots do not last long after digging, drying up or rotting. Since this variety of cassava is not the bitter or poisonous kind, it is generally known in Florida as the sweet cassava. The roots are fed to all kinds of stock in a fresh state and are greatly relished. It has been sufficiently tested here to show its great value as stock food. The yield, under favorable conditions, is astonishing. I have recently dug one plant of one year's growth which weighed fifty pounds, being at the rate of more than 1,500 bushels to the acre. Eight hundred to one thousand bushels per acre can be confidently reckoned on."

The roots received by us were long and slender and of various sizes; some of them were quite two feet long and weighed several pounds. The bark, which contains a poisonous principle if any be present, was carefully scraped off and has been preserved for subsequent examination. The analysis of the sample calculated to dry substance, is given in the following table:

Serial No.	5547	
Ash	1.94	per cent.
Oil (petroleum ether extract)	1.27	"
Ether extract (glucosides, alkaloids, organic acids, etc.)	.74	"
Alcohol extract (amids, sugars, resins, etc.)	17.43	"
Crude fibre	4.03	"
Starch	71.85	"
Albuminoids (calculated from nitrogen)	3.47	"
	100.73	

In regard to the method of analysis little need be said; it was carried on in accordance with the well-established rules of plant analysis as laid down by Dragendorff. The first extraction of petroleum ether gave the fat or oil alone, and the subsequent extraction with sulphuric ether gave the glucosides, alkaloids and organic acids. That portion of nitrogen existing as amids has been estimated in the alcoholic extract. The total nitrogen was also estimated and entered as albuminoids; a small portion of the nitrogen has thus been counted twice in the total results which add up a little over 100. A characteristic feature of the cassava root is shown in the large amount of substance present soluble in

alcohol. The amount of starch also compares fairly well with the best varieties of potatoes. On account of the large quantity of sugars present the cassava root could be more economically used for the manufacture of glucose than for starch; there is no doubt, however, of the fact that a fine article of starch food can be made from the cassava root growing in this country.

In addition to the fresh root above noted, two samples of the dried root or cassava meal have also been examined. No. 5,922 was sent to us described as pulverized manihot root or cassava flour. The root is first peeled, chopped into thin slices, dried in the sun two days and pulverized. It was prepared by Prof. W. H. Kern, of Bartow, Fla. No. 5,923 was labeled pulverized cassava with the starch, or a portion of it, and the glucose washed out, the remaining pulp dried in the sun, prepared by W. H. Kern, Bonnie Lake, near Bartow. Fla.

Prof. Kern sent a letter with the samples, from which the following extracts are made:

"Allow me to say that owing to the prodigious yield per acre of what we here know as cassava and its alleged value as a feed and food plant and for its yield of starch and glucose, it is attracting a very great deal of attention here now. The plant here grown is different from the manioc root of South and Central America; our root contains no poisonous elements which need to be dissipated by heat. It is customary here for many persons to make their own starch from it. The root, which must remain in the ground until one is ready to use it, is dug, washed and its two inner and outer peelings removed; it is then grated and the pulp washed, the water poured off in a vessel and allowed to stand, when the pure starch settles in the bottom. The clear water is again drawn off and the starch allowed to dry. The pulp, after having the starch washed out, may be used at once in making puddings by the addition of milk, eggs, etc. This washed pulp may be sun dried and thus kept, forming valuable meal or flour from which nice bread may be made. Necessitated, as we are in South Florida, to buy all our wheat flour, anything which acts as a substitute, either in whole or a part, is of great value to us."

The analysis of two samples of flour are given in the following table:

Serial No.	5922	5923
	Per Cent.	Per Cent.
Water	10.56	11.86
Ash	1.86	1.13
Oil and fat	1.50	.86
Glucosides, alkaloids and organic acids	.64	.43
Amids, sugars, resins	13.69	4.50
Dextrine, gum, etc., by difference	2.85	5.63
Crude fibre	2.96	4.15
Nitrogenous bodies	1.31	1.31
Starch	64.63	70.13

From the above analyses it is seen that the cassava can never take the place of the flour made from cereals as a food material on account of the small portion of nitrogenous matter which it contains. It seems to me, however, that it might very well take the place of potatoes, and its value as a food should not be underestimated.

Mr. S. W. Carson, of Midland, Fla., has made some very valuable contributions to the literature of the native cassava. From a letter of his to the *Florida Farmer and Fruit Grower* of April 11, 1888, I make the following quotations:

"As before stated, I regard the rolling pine lands, containing some willow oak, to be the best for cassava, and the southern counties to be the best suited to it. Let the soil be well prepared by plowing and harrowing, rows checked about four feet apart, one piece laid in each hill. I think they should never be closer together than four feet, and five would be better. Cassava has been known to grow for three years in this country. It will continue to grow until the cold kills it, then by breaking off the stems when they are red, the stubble will sprout up in the spring. As to the seeds of the cassava they will ripen in about one year. If puddings, custards, etc., are desired, the roots must be peeled and grated; salt, sugar, etc., may be used according to taste. The Spaniards make bread of it simply by grating the root and adding salt and a little soda. Now, there is no doubt in my mind but thirty tons of cassava root per acre can be produced. When I think of the tapioca, glucose and starch there are in it, and how abundantly it can be turned into bacon and lard, milk and butter, mutton and beef, I feel confident that it will pay better than any other plant in the world."

Mr. J. H. Moore, of Keuka, Fla., in a letter to the same paper of November 24, 1887, describes some of the uses of cassava. From his letter I make the following extract:

"Cut the stalks about one inch above the ground, just before frost; after cutting, the stalks should be left to dry in a cool place a few weeks, and then placed in a trench and covered until time for planting. Some save the stalks by keeping them in a dry, cool place until February and then plant. The roots should be dug as used; they will not keep in good condition out of the ground more than three or four days. It is, perhaps, the best feed we can raise for hogs; it is also a fine feed for poultry. We often bake it like sweet potatoes, and also slice and fry it like Irish potatoes."

M. Sacc has addressed a letter to the National Society of Agriculture of France concerning cassava, which he calls "Manihot utilissima." He is of the opinion that the poisonous varieties are different botanically from the innocent. Manihot is the bread of tropical regions. The innocent variety is cultivated in Bolivia, and the botanists there call it "Manihot Aïpi." The plant grows from one to two metres in height, with straight and naked stalks, since they only develop leaves at their extremities. The only care given

to them in their cultivation is to keep them free from weeds. The roots, to the number of 5 to 9, are of the size of the closed hand. The following analysis of the roots of the Manihot Aïpi is given:

Water	70.29	per cent.
Starch	14.40	"
Sugar, salts and malic acid	1.01	"
Fibrin and yellow coloring matter	.08	"
Crude fibre	3.16	"
Ash	10.82	"

From the above it is seen that the roots of the tropical plant are quite different from those produced in our own country. In regard to the distribution of the two varieties, M. Sacc makes the following observation:

"In Cuba I have seen only the poisonous variety. The same is true of Brazil, where I have not seen the Manihot Aïpi except in the Swiss colony, Porto Real. As to the product of the two varieties it is the same; the stalks, which are the size of the finger, are from one to two metres in height. I have not been able to analyze the leaves of this interesting vegetable, but, as they are much sought after by cattle, they are probably very nutritious."

The above quotation from M. Sacc's paper I have taken from the *Revue Agricole*, published at Port Louis, Maurice, vol. 2, no. 6, pp. 81 and 82.

The name cassava should be applied properly only to the purified starch derived from the roots of the plant. The plant is known under the botanical names, Janipha Manihot, Manihot utilissima, Jatropha Manihot, Manihot Aïpi and Jatropha Læfflingii; it is also called the mandioc plant. The fleshy root of this plant yields the greatest portion of the daily food of the natives of tropical America, and its starch is known in this country under the name of tapioca. Manihot is a woody or shrubby plant, growing from fleshy tuberous roots, the stems being smooth, the leaves being generally long-stalked. The leaves of the poisonous variety usually have seven branches palmately divided; the leaves of the sweet variety are usually only five-parted. In the "Treasury of Botany," p. 718, the following remarks are made concerning these two varieties:

"It is quite clear that while the root of one is bitter and a virulent poison, that of the other is sweet and wholesome, and is commonly eaten cooked as a vegetable. Both of them, especially the bitter, are most extensively cultivated over the greater part of tropical America, and yield an abundance of wholesome and nutritious food; the poison of the bitter being got rid of during the process of preparation it undergoes. The poisonous expressed juice, if allowed to settle deposits a large quantity

of starch known as Brazilian arrowroot or tapioca meal, from which the tapioca of the shops is prepared by simply torrefying the moist starch upon hot plates, the heat causing the starch grains to swell and burst and become agglutinated together. A sauce called *cassareep*, used for flavoring soups and other dishes, particularly the West Indian dish known as pepper-pot, is also prepared from this juice by concentrating and rendering it harmless by boiling. Another of the products of cassava is an intoxicating beverage called *piwarrie*, but the manner of preparing it is not calculated to render it tempting to Europeans. It is made by the women, who chew cassava cakes and throw the masticated material into a wooden bowl, where it is allowed to ferment for some days and then boiled. It is said to have an agreeable taste."

. From the above analysis of cassava root, descriptions of its uses and the amount of it that can be produced per acre, it is evident that it is destined to become a valuable agricultural product of the sub-tropical portions of our country.

Washington, D. C.

Histology of the leaf of Taxodium. I.

STANLEY COULTER.

(WITH PLATE XI.)

Following Endlicher, in his *Synopsis Coniferarum*, 1847, Taxodium distichum is placed in the sub-order Cupressineæ. Sachs suggests, however, that this arrangement of the Coniferæ can only be considered tentative, until further light is thrown upon the nature of female flowers of various genera.[1] As it is not the purpose of this paper to present any fact regarding this point, a general description of the appearance of the tree is alone given.

Under favorable circumstances, Taxodium distichum, the Ahuahete of the Mexicans, "reaches a height of 150 feet, with a trunk diameter of from 10 to 12 feet or more."[2] According to Humboldt, attaining a height of 120 feet, it has a diameter of from 32 to 40 feet.[3] It bears linear, acute, 2-ranked, crowded and deciduous leaves, from 5 to 8 mm. long, upon slender leafy branchlets, a part of which are also deciduous in autumn. Its range in the United States is from southern Delaware to southern Florida near the coast, and from Carroll county, Indiana, southern Illinois and Missouri, southward to Alabama, Louisiana and eastern Texas.[4]

[1] Sach's Text Book of Botany, 1st English Ed., p. 459.
[2] Sargent's Catalogue of the Forest Trees of N. A., p. 65.
[3] Aspects of Nature II, p. 94.
[4] Sargent's Catalogue Forest Trees of N. A. l. c.

Of extreme beauty and grace, it is the most frequently planted of the hardy deciduous Conifers for ornament,[5] while its light, compact and durable wood gives it a great value from an economic standpoint. In our own state (Indiana), while its range commences as far north as Carroll county, it is not found in any abundance until we reach the low lands of the lower stretches of the Wabash, where its large trunk with its pale, smoothish bark and its yew-like foliage, makes it a striking feature in the landscape.

In the study of the foliage leaf, great difficulty was encountered in the securing of sections in which tissues were not either lacerated by the razor or distorted by pressure. The strongly cuticularized epidermal cells and the extremely thin-walled cells of the mesophyll, may in a certain measure account for this. Various methods of imbedding were tried, but none succeeded. The method of Moll[6] brought some hope with it, although it was suggested in the article that with fully grown parts, perfect imbedding was extremely doubtful. A careful following of directions there given gave no satisfactory results, nor was any greater success attained in cases in which a portion of the epidermis had been removed.

The sections used in the study are therefore all free-hand, but so large a number of these was prepared that the results attained are considered accurate.

The gross appearance of the leaf is shown in fig. 1, in which "B" shows a leafy branchlet with its crowded 2-ranked, linear leaves, natural size; while "A" gives a single leaf in position, magnified 12 diameters.

In some of the leafy branches the leaves show a marked tendency to depart from their distichous arrangement, in some cases almost forming whorls, in others taking positions referable to no definite plan. Specimens received from different localities show such a variation in habit and size of foliage that it is not strange that many varieties and some species have been founded upon them.

I have in these studies made constant comparisons with the structure of the foliage leaf of Pinus sylvestris, which may perhaps be taken as a fair representative of that genus.

In transverse section, the leaf presents an almost perfectly elliptical outline, the variations consisting in the somewhat acute form in the direction of the longer axis, and a depres-

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[5] Hemsley's Hardy Trees, Plants and Shrubs, p. 451; Paxton's Bot'l Dict'y, p. 549.
[6] BOTANICAL GAZETTE, xiii. 5.

sion on both leaf surfaces in the direction of the shorter axis (fig. 2).

In passing from the periphery to the center, three distinct regions are to be noticed: (1) A well-defined epidermal system; (2) the mesophyll, made up for the most part of somewhat large parenchymatous cells; (3) the fibro-vasculer bundle near the center.

I. *Epidermal system.*—The epidermal cells in transverse section show a slight irregularity both in size and shape. The prevailing form appears to be elliptical, with the longer diameter, in the line of the greater leaf axis, to the shorter as two or three to one. In the depressions referred to above, which occur immediately above and below the fibro-vascular bundle, the cells become more nearly equal in their diameters, and in some cases that in the direction of the shorter leaf axis is the greater. At the extremities of the longer leaf axis the epidermal cells are somewhat peculiarly modified. The extreme cell is ordinarily much smaller than those on either side, which by their excessive development and remarkably thickened inner walls separate it entirely from the underlying parenchyma. In occasional cases this modification of the adjacent cells is not so marked, but there is found instead one or more rows of thick-walled "strengthening cells," extending from the apical cell back into the parenchyma. This arrangement is evidently a special one, as nowhere else does the epidermis show the slightest tendency to become of two layers, and at this point the mode of its occurrence is such that it probably can not be referred to this condition. In these smaller apical cells, the walls are of comparatively great thickness, almost obliterating the cell cavity. No marked differences are to be observed in this section between the epidermal cells of the outer and inner surfaces, unless it be that in the latter the average cell length is less than in the former. (See figs. 2, 3, 4 and 5.)

A surface slice (fig. 6) shows the epidermal cells to be of somewhat irregular outline, with their diameters of varying proportion to each other. They are, however, more nearly isodiametric than would be expected in a plant with narrow linear leaves, in which case, according to de Bary, "the longitudinal diameter is greatly extended."[7] The outer walls are heavily cuticularized and in nearly equal degree throughout the outline of the leaf. The cuticular layers are extremely dense and tough. The non-cuticularized layer is rela-

[7]De Bary, Comparative Anatomy of Phanerogams and Ferns, p. 30.

tively thick, and shows no tendency to thin out where it borders upon the cuticular layers. In this it resembles the condition in Pinus, and differs from that found in the under surface of the leaf of Taxus baccata, in which the non-cuticularized layers are scarcely to be detected where they border upon the cuticular.[8]

The cuticularized portions follow the outer surface of the epidermal cells and project inward in somewhat sharply-pointed conical form. In many instances the cuticular layer is largely developed at the stomatic furrow, although as a rule this may not hold.

The epidermal cells contain nothing further than the characteristic contents of such cells, although in the cuticular layers are found thickly massed granules, presumably calcium oxalate, as treatment with acetic acid produced no effect, and as this substance is not uncommon in the Cupressineæ.[9] No crystalline forms were found, and although the substance was present in comparatively large quantities, no modification in the coloration of the epidermis could be detected. The walls of the epidermal cells, especially the inner ones, are extremely irregular and show numerous infoldings, which in some instances are very prominent. There seems to be no special order in their disposition, either as regards the individual cell or the other tissues of the leaf, although the larger forms are more frequently found in the region of the resin duct than elsewhere. It is also possible that those of the inner leaf surface may be more prominent than those of the outer. The purpose of these infoldings I have been utterly unable to determine, their irregular arrangement and development negativing every conjecture. In view of some facts to be presented later in this paper, it is at least within the range of possibility that they serve for purposes of support.

A median vertical longitudinal section illustrates still further these points (fig. 10). The apex of the leaf is formed by a continuation of the epidermal cells of the inner surface, the apical cell being of this series. The two cells immediately adjoining the apical cell of both the outer and inner surface are in immediate contact, no parenchyma intervening. Those of the outer surface are much modified in form, while those of the inner retain their normal shape. At the third cell from the apical cell, there occurs a peculiar modification, due either to the presence of extremely short

[8] De Bary, Comparative Anatomy of Phanerogams and Ferns, p. 77.
[9] De Bary, l. c., p. 102.

"strengthening cells," or to the division of the epidermal cell of the outer leaf surface into three layers. This arrangement serves, of course, to give still further rigidity to the leaf apex. At this part of the leaf the epidermal cells of the inner surface are much longer than those of the outer surface (as seen in this section), seeming in the one case to be lengthened, in the other shortened (figs. 9 and 10, cf. also fig. 3).

The stomata in surface slice appear widely elliptical and have the depressed position usually found in thick-skinned parts. In size, they are perhaps from one-third to one-half that of the surrounding epidermal cells, and are relatively equal to each other. The stomata are irregularly arranged in this view, both as regards the surrounding epidermal cells and the relation of their axes. In transverse section the guard cells are almost perfectly oval, with their outer walls heavily thickened or from three to five times thicker than their inner walls. This thickening appears to be greatest at or near the point of union with the subsidiary cells, but extends in an almost undiminished degree to the free ends. The free ends show no difference either in shape or size from the united ends, presenting a marked contrast to Pinus, in which the reverse is true. They meet each other at an angle of about 45° as referred to their longer diameter, and open into a remarkably large respiratory cavity. (Fig. 7.)

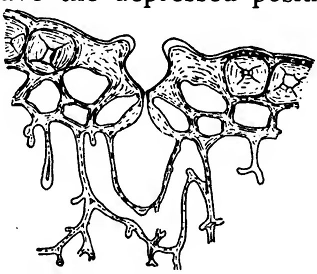


Fig. 8. Section of stoma of Pinus sylvestris x 650.

The adjoining epidermal cells are but slightly modified, those immediately adjacent having their lateral walls which join the guard cells modified in shape only as would be indicated by the outline of the guard cells. The inner walls of these cells are in most cases more irregular in outline and more heavily thickened than the ordinary epidermal cell.

The guard cells are depressed below the surface about one-half the height of the epidermal cells, so that in a surface slice it is necessary to focus down to bring them in view. The epidermal cells next removed from the subsidiary cells are somewhat shortened, becoming almost isodiametric as viewed in both transverse and surface sections. The subsidiary cells are also as a rule more heavily thickened and cu-

ticularized at the stomatic furrows than elsewhere. The intercellular cavity shows numerous and somewhat prominent infoldings, a characteristic common also to Pinus. The contents of the guard cells are protoplasm and chlorophyll with their included bodies.

A transverse section usually shows eight stomata, in relatively definite positions, six on the outer and two on the inner surface of the leaf. In exceptional cases the number may vary upon the outer surface, but in the sections examined no more than two have been detected upon the inner surface. Upon the upper surface the stomata are usually about equidistant from each other. Those of the inner surface seem to be placed about midway between perpendiculars let fall from two of the upper stomata. (Figs. 2, 3, 4, 5 and 7.)

The stomatic system seems to be of the simplest and is much different from that in Pinus sylvestris in the shape and thickening of guard-cells, in the modifications of the subsidiary and surrounding epidermal cells, and in the shape and outline of the furrow. The similarity consists chiefly in the relatively large respiratory cavities and the infoldings mentioned above. As a whole, in comparison with Pinus the stomatic mechanism seems much less completely developed both as regards its differentiation from the surrounding tissues and its means for controlling transpiration. (Cf. figs. 7 and 8.)

Purdue University, Lafayette, Ind.

OPEN LETTERS.

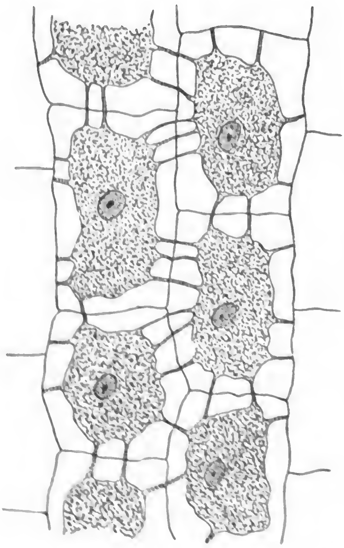
The "King-Devil."

In connection with Mr. Lester F. Ward's article on the "King-Devil" in the January GAZETTE, it may be interesting to note that *Hieracium aurantiacum* L. has appeared on my place here. The locality is in a wet meadow, and I first discovered it in the summer of 1884, when there was a single flowering stalk. This has increased slowly until last summer there were six or eight flowering stalks, but so far it has shown no indications of becoming a troublesome weed. As to the manner of its introduction, I can only say that my uncle, the late Mr. Oscar Harger, of New Haven, once had the plant growing in his garden, and it may have been introduced from there in some way, although as the distance is about fifteen miles, the probability seems small. E. B. HARGER.

Oxford, Conn.

BRIEFER ARTICLES.

Continuity of protoplasm.—In demonstrating this very important fact, Strasburger[1] directs the use of the strongest objectives, and, where possible, immersion objectives. This at once puts it out of the reach of many laboratories, where the teacher is thankful if he gets enough ordinary objectives. The information, therefore, that protoplasmic continuity can be easily demonstrated, with very little manipulation and very ordinary objectives, ought to be helpful to many. The most favorable object used is the secondary cortex or "green bark" of dicotyledons. Strasburger suggests the buckthorn, Rhamnus Frangula; Goodale mentions any "dicotyledonous shrub or tree." In most of these cases the connecting fibrils are so delicate that the highest objectives are neccessary to demonstrate them. But in the common buckeye the strands which connect the plasmic bodies are so large as to be satisfactorily seen with a magnification of 250 diameters, and very well studied with a magnification of 500 diameters, and in neither case is there any necessity of using an immersion objective. To repeat very briefly the method of preparing the specimen, and omitting all details that were found unnecessary, it is as follows: Use a buckeye twig about ¼ to ½ inch in diameter (those a year or two old seem best): carefully slice off the periderm so as to expose the "green bark"; make a thin tangential section from this latter; immerse this in an aqueous solution of iodine (or, better, iodine in a solution of potassic iodide) until it turns brown, which will take but a moment; wash the section thoroughly to remove excess of iodine; mount in water; at the edge of cover slip put a drop of chemically pure sulphuric acid and two drops of dilute (about 75 per cent.) sulphuric acid, and draw this mixture under[2]: thoroughly wash the specimen by drawing plenty of water through (this is very important): replace the water of the mount with glycerine and the specimen is ready to observe. If the work has been successfully done, even a low power will reveal the very much swollen and transparent walls crossed in every direction by proto-

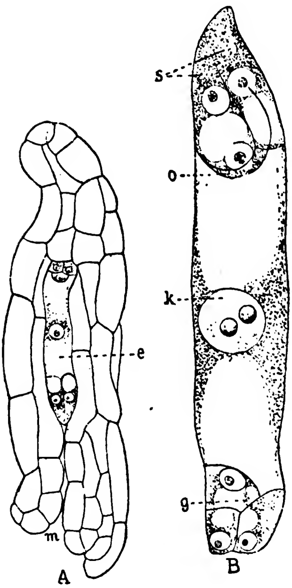

Continuity of protoplasm in secondary cortex of buckeye.

[1]Practical Botany, Hillhouse translation, p. [illegible]; Hervey translation, p. 364; described in Goodale's Physiol. Bot., p. [illegible].

[2]It may be easier to dip the section directly into the sulphuric acid and then wash thoroughly.

plasmic strands connecting the contracted brown plasmic bodies as shown in the accompanying cut. To make a permanent mount, it will be necessary to use some stain for the plasmic bodies and their connecting strands; otherwise the strands gradually become so transparent in the glycerine as to be almost invisible. The ease of demonstration in case of the buckeye, as compared with other dicotyledons previously used, depends upon the fact that the plasmic protuberances do not break up into delicate fibrils on entering the walls. This demonstration was made by Mr. Evans, my assistant, and the sketch by Mr. Seaton, a special student. —JOHN M. COULTER, *Botanical Laboratory, Wabash College.*

Monotropa uniflora as a subject for demonstrating the embryo-sac.— In the "Botanisches Practicum,"[1] Strasburger figures the embryo-sac of Monotropa Hypopitys as the most favorable plant known to him for its study in the living state.



A. Ovule of Monotropa uniflora in optical section, X about 100: *m*, micropyle; *e*, embryo sac. B. The embyro-sac of a similar ovule, X about 300: *s*, synergidæ; *o*, oosphere; *k*, endosperm nucleus (the two endosperm nuclei have united, but their nuclei are still distinct); *g*, antipodal cells.

I have found M. uniflora to be even better suited to this purpose owing to the greater size of the ovules and embryo-sac, the latter being just about twice as long as that of the former species, and showing quite as clearly all the details of its structure.

It is only necessary to strip away a little piece of the placenta with the adherent ovules and mount in water, or, better still, a weak (about 3 per cent.) sugar solution. In the latter fluid the ovules remain unchanged for several hours, and may be studied at leisure.

The embryo-sac is covered with but two layers or cells, and these are perfectly colorless, so as not to interfere in the slightest with the view of the embyro-sac.

M. uniflora is not at all a rare plant and may usually be had throughout the summer. The specimen from which the accompanying figures were made was collected at Bloomington, Sept. 24.

The figures are from camera drawings and will give a good idea of the structure of the ovule and embryo-sac.—DOUGLAS H. CAMPBELL, *Bloomington, Ind.*

[1] Hillhouse's translation, p. 331.

EDITORIAL.

THE AGRICULTURAL EXPERIMENT STATIONS are now fairly launched on their way, and their reports are beginning to come in rapidly. Some of them are valuable, some are worthless, evidently having been made to order. It is, perhaps, hardly fair to make such a criticism so early in the history of these stations, but we wish to do them a service if possible. The requirements of a report at certain stated intervals is American, but dreadfully unscientific, and the general supposition is that at these stations, at last, we have endowment for research and not simply one for "reports." If they are to begin at once with reports upon all sorts of hasty and meaningless experiments, we shall be worse off than we were before. We thoroughly understand that many in charge of this work can not perform any other kind of experiments, and concerning these we have nothing to say. But there are those in charge who know how to work, for they have already made a record, and we want to see the opportunity given them. The popular American idea is to experiment two or three weeks, and then write a report, and if real workers are compelled to come under such an order of things, their publication can be but little better than others. We would protest, therefore, against compelling a botanist at one of these stations to write a report when he has nothing to say. He must not be hurried even, for the best experimental work can only be done with the idea of unlimited time as a factor. A station director must know that his man is competent, that he is actually doing work, and then wait patiently for results. The ability to get out a report at short intervals ought to be taken as an indication of a man's incompetency as an investigator. If the requirement of "reports" from the scientific staff of these stations could be removed, and only monographs prepared after ample investigation, our new venture might really prove the beginning of an endowment for research.

CURRENT LITERATURE.

Watson's Contributions to American Botany.

A great herbarium should always be productive, and it is of inestimable advantage to American botanists that our greatest herbarium has always had in it men with the spirit and ability to work. The accumulation of a great herbarium which contributes little or nothing to general botanical knowledge is hardly better than a miser's accumulation of money. The "Contributions" from the Harvard Herbarium form a set of botanical publications that no working botanist can be without, or else he will be working in the dark.

The last of these is before us.[1] The first part is a report of a collec-

[1] WATSON, SERENO.—Contributions to American Botany. xvi. (Proc. Am. Acad. xxiv, pp. 36–87)). Issued Jan. 31, 1889.

tion of plants made by Dr. E. Palmer, in 1887, chiefly about Guaymas, Mexico. The season was very dry and unfavorable, and this, too, in a country that is normally dry and unfavorable, and yet 415 native species were collected, 89 of which are wholly new. This region of the Gulf of California is one of great interest botanically. It is probably the northern limit on the Pacific coast of such tropical genera as Rhizophora, Hæmatoxylon, Citharexylum, Ficus, etc. Among the 415 species, there are 50 Gramineæ, 50 Compositæ, 44 Leguminosæ, and 32 Euphorbiaceæ. The important orders Ranunculaceæ, Rosaceæ, Saxifragaceæ, Umbelliferæ, Ericaceæ, Cupuliferæ, Coniferæ, and Orchidaceæ are wholly unrepresented. Excluding Cyperaceæ and Gramineæ, there are only 5 endogenous species in the entire collection. The new genera proposed are *Malperia* (Agerateæ among Compositæ), *Pelucha* (Plucheineæ among Compositæ), and *Pattalias* (Asclepiadaceæ). The second part contains descriptions of new species, chiefly Californian, and also proposes the restoration of *Sisyrinchium anceps* Cav. Dr. Watson finds that two forms can be readily distinguished, one (*S. anceps* Cav.) with branching stems and globose strongly pitted seeds less than half a line in diameter, the other (*S. angustifolium* Mill.) with simple stems and angled less pitted seeds about twice larger than the other.

Saccardo's Sylloge Fungorum.[2]

Two more volumes of the Sylloge are before us, volume VI and the second part of volume VII, and but one volume remains to complete this great work. The invaluable service to mycologists in thus bringing together in convenient form descriptions of all known fungi has already been alluded to in notices of the earlier volumes. The present parts follow the treatment already well established, and which it is unnecessary to describe in this connection.

The sixth volume contains descriptions of 3911 species, being more than quadruple the number belonging to these orders known when Fries published his Epicrisis in 1838, and still the harvest of new species is unabated.

The first part of the seventh volume was noticed recently; the second part, now before us, deals with the Ustilagineæ and Uredineæ, two specially interesting groups of parasitic fungi. As there have been many collectors of these plants in North America, there are consequently a considerable proportion of the species accredited to this country—of the Ustilagineæ nearly one-fourth.

As in every other work touching upon the classification of these groups, the protean changes of synonymy bring to light old, new, or little

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[2] SACCARDO, P. A.—Sylloge fungorum omnium hucusque cognitorum; Vol. VI, Polyporeæ, Hydneæ, Thelephoreæ, Clavarieæ, Tremellineæ. 928 pp., roy. 8 vo. Patavii, 1888.—58 francs.

Same; Vol. VII, Pars II, Ustilagineæ et Uredineæ, digessit J. B. De Toni. 882 pp., roy. 8 vo. Patavii, 1888.—29 francs.

known names to replace those in use. For example, we find Ustilago Candollei given as Sphacelotheca Hydropiperis, Puccinia Petalostemonis transferred to the genus Uropyxis, established by Schröter for the curious Puccinia on Amorpha, Puccinia vertisepta from New Mexico changed to Diorchidium Tracyi, Melampsora Epilobii and M. Crotonis both placed under Pucciniastrum. One notices by this that a number of genera, not heretofore much in favor, have been reinstated. The Æcidia forms have been distributed so far as possible, and especially so under Gymnosporangium.

The thing that one misses in these volumes, and yet a thing scarcely to be expected in such a compilation, is a critical valuation of the species. In fact it takes no very extensive knowledge of the American flora, to be able to eliminate a number of the so-called species as having no just claim to recognition, and to add to the range of other species. But with all faults of omission and error, to a large part inseparable from such an undertaking, the work is still one of great value, and will do much toward helping and elucidating the systematic study of fungi.

Minor Notices.

DR. C. C. PARRY has just published a revision[3] of the genus Ceanothus, based upon field observations on the Pacific coast covering a period of forty years. The work heretofore has necessarily been done with fragmentary herbarium specimens, and Dr. Parry's observations supply much needed information. Before enumerating the species the author makes some very interesting general observations, and also discusses the characters by which species and groups can be most satisfactorily defined. The Pacific coast of California constitutes the most suitable home for the genus; "and in its varied aspects of soil and climate, invites to the largest display of specific forms." In California the greatest profusion and variety of forms are found in the Santa Cruz range of mountains. Two new species are described, *C. Andersoni* and *C. divergens.*

IN THE PUBLICATION referred to above, Dr. Parry discusses certain species of Chorizanthe and describes two new ones, *C. Andersoni* and *C. robusta.*

THE FIRST BULLETIN from the laboratories of Iowa State University is before us. It is a publication of 96 pages, containing eight articles, three of which are botanical, with the following titles: The saprophytic fungi of E. Iowa—the genus Agaricus, Series I and II, by T. H. McBride; The Peronosporeæ in Iowa, by T. H. McBride and A. S. Hitchcock; Botanical notes, by T. H. McBride. The botanical notes speak of spore-dispersal among fungi, an undesirable immigrant (Solanum rostratum), and a mould growing in hydrochloric acid.

[3]PARRY, C. C.—Ceanothus L. A synoptical list, comprising 33 species, with notes and descriptions. (Proc. Davenport Acad. V, pp. 162–174.) Issued Feb. 9, 1889.

NOTES AND NEWS.

A GOOD ACCOUNT of the Botanic Garden at Glasgow will be found in *Gard. Chron.*, Jan. 26.

PROF. DR. GOEBEL, of Marburg, assumed with this year the editorship of the well-known journal, *Flora.*

M. HENNECART, Nestor of French botanists, died at Paris, 23d of last December, 91 years of age. He was born in 1797.

THE MICHIGAN Forestry Commission report for 1888 contains much information concerning the lumber interests of that state.

COUNT SOLMS has recently published a MS. monograph of the Saprolegnieæ left by the lamented de Bary. Bot. Zeit. 1888, nos. 38–41.

DR. FR. JOHOW, privatdocent at the University of Bonn, has been called to the chair of biology in the Normal School at Santiago, Chili.

DR. PFEFFER, of Tubingen, has been elected one of the fifty foreign members of the Linnean Society, in place of the late Prof. Planchon.

PROF. JOSEPH F. JAMES has published, in *Jour. Cin. Soc. Nat. Hist.* (Jan.), an account of the distribution of Vernonia in the United States.

THE FOURTH PART of Jane H. Newell's "Outlines of Lessons in Botany" has been published. It consists of a study upon buds and branches.

FRANCIS DARWIN, heretofore lecturer in botany in Trinity College, Cambridge, has been elected lecturer on botany in Christ College, vice Dr. Vines.

IN BULLETIN 3 from the Iowa Agricultural Experiment Station Mr. A. A. Crozier gives a popular description of some of the most common injurious fungi.

BULLETINS 59 and 60 from the N. C. Agricultural Experiment Station contain articles on the purity and vitality of seeds, and the value of lucerne as a forage crop.

REV. ARTHUR C. WAGHORNE, of New Harbor, Newfoundland, has published an account of the wild berries and other edible fruits of Newfoundland and Labrador.

RECENTLY biographical sketches of Dr. de Bary have been published in the Berichte der deutschen bot. Gesellschaft (General-Sammlung) and the Botanische Zeitung (1889, no. 3).

IN *Journal of Botany* (Feb.), *Potamogeton varians* Morong in herb. is described by Alfred Fryer. It is common to Britain and America, and seems to be the *P. gramineus*, var.? *spathulæformis* Robbins of Gray's Manual.

THE DECORATION of the Legion of Honor was awarded by the French government on last New Year's day to Prof. F. L. Scribner, of Tennessee, T. V. Munson, of Texas, and Jaeger of Missouri, in recognition of their studies of the grape and its diseases.

GUIGNARD[1] reports the results of recent investigation of the development of antherozoids of the Characeæ. The nucleus of the mother-cell forms the whole of the body of the antherozoid, the protoplasm forming the cilia only. In these plants there is no vesicle attached.

[1]Comptes Rendus de l'Acad. Sci. CVIII. 71. See, also, Revue générale de Bot. no. 1.

THE LARGER part of Professor Dudley's article on the Strassburg Laboratory, given in the December number of this journal, has been reprinted in *Nature* for January 17, "as showing the sort of provision for botanical study that is thought right and necessary in Germany."

IN THE *Bulletin of Torr. Bot. Club* (Feb.) Mr. Bebb gives a second paper upon White Mt. willows, in which *Salix phylicifolia* L. is discussed, being *S. chlorophylla* And., Gray's Man. Ed. 5, excl. char. In the same number Mr. Morong gives his first impressions of South American vegetation.

THE INDIANA Agricultural Experiment Station has published a bulletin (No. 19) upon the spotting of peaches and cucumbers. The peach spot is *Cladosporium carpophilum* Thuem., and heretofore has been recorded only as occurring in S. Austria. The cucumber spot is *C. cucumerinum* E. & A.

PLANT ILLUSTRATIONS in recent numbers of the *Garden and Forest* are as follows: *Cereus Pringlei* Watson (Feb. 6), a gigantic cactus of Mexico, not so tall as C. giganteus, but with more ponderous branches than any cactus known; and *Rosa humilis* Marsh. (Feb. 13), the R. lucida of Gray's Manual.

DR. MAXWELL MASTERS (*Gard. Chron.*, Feb. 9), in giving an account (with capital illustrations) of *Abies lasiocarpa* Hook., concludes that, for garden purposes at any rate, *A. subalpina* Eng. should be considered to be *A. lasiocarpa* Hook. and *A. bifolia* Murray; and that *A. lasiocarpa* of the gardens is *A. Lowiana.*

THE SERIES of articles on physiological botany by Dr. Goodale in *Garden and Forest* is of great interest to those botanists who do not keep step with the advance of botany in physiological lines, as it compactly and clearly presents our best knowledge of the subject. The series began in the first number of the current year.

IN *Journal de Botanique* (Jan. 16), Abbé Masclef discusses *Daucus hispidus* DC., referring it to the interminably variable D. Carota, a thing that might be done with our own D. pusillus with no great violence. In the same number N. Patouillard begins a study of the genus Lachnocladium, describing nine species, two of which are new.

DUCHARTRE has recently observed the formation of numerous (as many as twenty) adventitious roots by the endosperm of Cycas Thouarsii, a Comoro species. Most of the seeds are without embryos. The roots start from the neighborhood of the micropyle. If the endosperm is the equivalent of the prothallium, then this is a peculiar form of apogamy.

AN ILLUSTRATED monograph of British Hieracia is being prepare by Frederick Jansen Hanbury. It is to be done in a most elaborate way, appearing in quarterly parts, the estimate being that it will be completed in five years. The annual subscription is 24 shillings for colored, and 16 shillings for uncolored copies. Subscriptions are to be sent to the author at 69, The Common, Upper Clapton, London.

SEVERAL new species of fossil woods have been described by Mr. F. H. Knowlton in the Proceedings of the National Museum for 1888. The diagnostic characters are mostly drawn from the microscopic structure; the plates show the cells in a surprisingly perfect state of preservation. The species include an araucaria (Araucarioxylon) from Arizona, a cypress (Cupressinoxylon) from Iowa, another cypress from Montana, and a palm (Palmoxylon) from Louisiana.

PROF. JAS. ELLIS HUMPHREY, of the Mass. Agricultural Experiment Station, has been invited to act as collaborator on the *Botanisches Centralblatt*, the well-known weekly résumé of current botanical literature. Dr. Uhlworm, the editor, wishes to have the work of American botanists more fully represented in his pages than heretofore, and Prof. Humphrey will be glad to receive reprints of all future American papers containing original matter, for abstract.

AMANN finds that the whitish coating which gives the glaucous appearance to the leaves of Leptotrichum glaucescens is a crystallizable substance which he calls "Leptotrichum-säure." This is the first crystallizable substance yet obtained from mosses. It is soluble in ether and hot alcohol, from which it may be recovered in crystals or a flocculent precipitate respectively. The crystals are tasteless and odorless. The small quantity available has not yet permitted a complete chemical study of the substance.

THE AGRICULTURAL Experiment Station at Knoxville, Tenn., has secured the entire collection of Dr. A. Gattinger of Nashville. This collection is a very valuable one, the result of 30 years of work of an indefatiguable and acute botanist. It is very nearly complete for that very interesting state, and Dr. Gattinger's correspondence has also secured much material from other parts of the United States. With Prof. Scribner in charge of the botany of the station, this rich collection at once becomes the common property of all working botanists.

A WRITER in a late number of *Education* points out that the dictionaries (Webster and Worcester) are wrong regarding the accent and meaning of the word Arbutus. He quotes from Horace, Virgil and Ovid to show that the accent should be on the first syllable, and from Aristophanes and others for the meaning, which is having the properties of the arbor or tree. It will be found that in the works of Asa Gray the word is properly accented, while in Hooker's Flora of the British Isles, and possibly other English works, the accent is on the second syllable.

ANOTHER JOURNAL, the *Revue générale de Botanique*, has been started with the new year, designed to cover all departments of the science. Its list of editors includes such well known names as MM. Bonnier, Dufour, Flahault, Costantin, Leclerc du Sablon and Saporta. It is a monthly of 36 to 48 pages, at 22.50 francs ($4.50) a year outside of France. Subscriptions are to be sent to the publisher, M. Paul Klincksieck, 15 Rue de Sèvres, Paris, and communications and papers for review to M. G. Bonnier, 7 Rue Amyot, Paris. The first number will be sent free to those interested in botany making known their desire to see it.

THERE HAS been recently patented in Germany by Dr. W. Koch and Max Wolz a novel arrangement for transmitting light through glass rods for the purpose of illuminating inaccessible parts of the body, such as the larynx. The same principle has been applied to the illumination of objects on the stage of the microscope. It is well known that light impinging upon the surface of glass at a less angle than 40°, suffers total reflection. The novel illuminating apparatus therefore consists of a hooded lamp, with a glass rod curved properly extending from a hole in the metal hood to the aperture in the stage. The light entering the end of the rod suffers numerous total reflections, until it reaches the end, where it emerges. The advantages for night work are sufficiently obvious. and the low price (M. 15) puts it within easy reach. The apparatus is manufactured by two firms in Bonn, Marquart (C. Gerhardt), and Max Wolz.

IN THE PART OF HOOKER'S *Icones Plantarum*, just published, is a description of a gigantic ice-plant of S. Africa, whose "leaves are so juicy that it not only furnishes the cattle with moisture in that country, but is used by Europeans in traveling for the purpose of washing, and even drinking, the water squeezed out being devoid of taste." (*Gard. Chron.*, Jan. 19.)

M. BUYSMAN, of Middelburg, Holland, whose preparation of analytical herbaria we have already noticed (BOT. GAZETTE, xiii. 326), in a private letter calls attention to a change in the mode of preparation by his collaborators. The necessary fragments and flowers are not to be sent in bottles, as previously mentioned, but in tin boxes thoroughly moistened with alcohol. This change has been suggested by Dr. Schweinfurth. The tin boxes, and alcohol if necessary, will be furnished by M. Buysman to all who desire to help him. Only the colored flowers he wants dried and spread out. The aid of American botanists is asked in supplying the medicinal and useful plants (cultivated or not) of this country. All necessary expenses are to be paid by M. Buysman, to whom application may be made for fuller information.

BOKORNY has recently confirmed to some extent Bäyer's theory of assimilation, viz.: that green plants in light reduce CO_2, CO remaining loosely combined with the chlorophyll, and from this some simple substance (such as formic aldehyde, CH_2O) is first formed, which is subsequently converted into a carbohydrate. Experimenting with Spirogyra, he excluded CO_2 and furnished instead formic aldehyde, methylal, methyl alcohol, glycol, or glycerin. Formic aldehyde proved poisonous, but from all the other substances the plants were able to manufacture starch and increase their dry weight. That they are able to convert these substances into a carbohydrate is not demonstrative evidence that they actually form these substances in the course of manufacture of carbohydrates from CO_2, but it increases the probability that they do.

WIESNER, in a preliminary paper in the Bot. Zeitung (1889, nos. 1, 2), undertakes to show that the older parts of plants by their transpiration draw on the water supply of the younger and that this affects greatly the development of these parts. The water so sucked away from the upper parts he speaks of as "the descending water stream." In general the buds, axillary and terminal, as well as the shoots arising therefrom, are hindered more or less completely in their development by rapid transpiration and accelerated by slower. By thus affecting the development of growing points, it is the transpiration and not the innate constitution of the plant which determines the production of sympodial shoots, or of false dichotomy. This his experimental evidence seems to confirm, since he was able to cause the abortion or development of the terminal bud by regulating the transpiration. The effect of transpiration is of course not direct. It acts by altering the turgor of the cells, the plasticity of the cell-wall, and possibly the structure of the protoplasm in the growing points.

New mosses of North America. II.

F. RENAULD AND J. CARDOT.[1]

(WITH PLATES XII-XIV.)

Microbryum Flœrkeanum Sch. var. HENRICI. — Differs from the typical form in the green color of the plant and the excurrent costa, often hyaline at the point.

Kansas: Saline county, on sandy ground (*Joseph Henry*).

Weisia viridula Brid. var. NITIDA.—Characterized by the shorter leaves, and the narrow, subcylindrical capsule, shining as though varnished and distinctly sulcate when dry.

Florida (*Fitzgerald*). Louisiana: Station Slidell, on sandy ground (*A. B. Langlois*).

Dicranum hyperboreum C. Müll. var. PAPILLOSUM.—Differs from the type in its leaves shorter, deeply canaliculate, papillose on the back, and the costa strongly rugose.

Greenland.

DICRANUM SABULETORUM.—In compact green or yellowish tufts. Stems 2-4 cm. long, simple or dichotomous, covered below with ferruginous tomentum. Leaves erecto-patent or subsecund above when moist, flexuous and somewhat crispate when dry, oblong-lanceolate, long narrowed-acuminate, generally somewhat inflexed at margins, subcanaliculate, smooth or papillose at back, serrulate above, 4-6 mm. long, .75-1 mm. broad; costa percurrent or excurrent, generally papillose and denticulate at back above, sometimes nearly smooth. Cells of the areolation short, angular, irregular in the upper part, linear, elongated toward the base, the alar large, lax, quadrate or subhexagonal, orange-brown. External perichætial bracts from a broad base suddenly constricted into a more or less elongated denticulate point, the inner convolute, sheathing, abruptly subulate from the rounded apex. Pedicel yellowish, 20-25 mm. long. Capsule

[1] Provisional diagnoses of most of the following mosses have been issued in *Revue Bryologique*, 1888, no. 5.

pale, cernuous or suberect, oblong or subcylindrical, arcuate, slightly plicate when old, with a small strumose neck. Lid conic, with a long subulate beak. Annulus distinct, teeth purple, cleft to the middle or below into 2-3 quite free or often more or less coherent legs.

D. pallidum BS. *Bryol. Eur.* mem., non C. Müller *Syn.* I, 359, nec plurim. auct. *D. spurium* var. *condensatum* Lesq. et James, *Manual* 76, non *D. condensatum* Hedw. *D. arenarium* Ren. et Card. mss. in litt. et sched.

"In arenosis siccis meridionalibus." (Sull. and Lesq. *Musci bor. Amer. exsicc.*) "In dry sandy places on hills, especially in southern districts." (Lesq. and James, *Manual*, 76.) We have this plant from Florida (*Fitzgerald*, *Sawyer*), Louisiana (*Langlois*) and Carolina (*H. A. Green*). Probably in all the southern states.

Since the establishment of our species in the *Revue Bryologique*, we ascertained from the examination of two authentic specimens of *D. pallidum* BS., in the herbarium of the Botanical Garden of Brussels, that this plant, only mentioned by the authors of the *Bryologia Europæa* as a species closely resembling in habit the *D. Muhlenbeckii* BS., is identical with the *D. spurium* var. *condensatum* of the American bryologists, from which we have made our *D. sabuletorum*. Therefore, the name of *D. pallidum* BS. should be retained by right of priority. But, as Müller, in his *Synopsis*, described erroneously under the name of *D. pallidum* BS. a form of *D. scoparium*, and as it is generally this form which is known in the current literature as *D. pallidum*, it seems to us to be most convenient to adopt a name about which there can be no mistake, and therefore we retain our name of *D. sabuletorum*.

This species is intermediate between the *D. spurium* Hedw. and the *D. Muhlenbeckii* BS. and *D. brevifolium* Lindb., differing from the first in its much narrower and not undulate leaves, and from the last two species in the form of its perichætial bracts, and the thinner walls of the cells of its leaves.

Dicranum scoparium Hedw. var. SULCATUM. (Florule de l'ile Miquelon, 44.)—Differs from the typical form in the following characters: tufts yellowish; stems more slender; leaves often flexuous, erecto-patent or subsecund, narrower and more narrowly subulate, more sharply serrate above; cells of the areolation habitually destitute of chlorophyll, less

porose, rather thin-walled; pedicel pale yellow, more slender, sharply twisted; capsule pale, tawny, deeply sulcate when old, and provided with more distinct longitudinal bands of orange-colored, elongated, sinuous and thick-walled cells.

Miquelon Island (*Dr. Delamare*).

By the pale tint of the tufts, pedicels and capsules, this remarkable variety, with rather the appearance of *D. longifolium*, belongs to the group of forms generally designated as *D. pallidum* C. Müll., or *D. scoparium* var. *pallidum*, but it is distinct by its narrower leaves, with a longer and more sharply serrate subula and its deeply sulcate capsule.

DICRANUM HOWELLII.—In soft, rather silky, yellowish green tufts. Stems slender, erect, simple or dichotomous, tomentose below, 4–12 cm. long. Leaves not crowded, secund or erecto-patent, narrowly lanceolate, long subulate, nearly setaceous, serrate in the upper half, often slightly undulate when dry, 6–10 mm. long, .75–1 mm. broad at base; costa more or less serrate at back toward apex; cell-walls porose, but scarcely thickened. Inner perichætial bracts sheathing, rather suddenly narrowed into a long flexuous point, entire or coarsely sinuate at base of the subula. Pedicel pale, at last sharply twisted to the left, 25–35 mm. long; capsule rufescent, cylindraceous, arcuate, slightly plicate when old; lid with a long curved beak. Inflorescence monœcious or pseudo-monœcious; male flowers sessile, axillary, or set upon small, slender flexuous branchlets.

Oregon (*Th. Howell*, *L. F. Henderson*).

This plant is a remarkable form, belonging to the group of *D. scoparium*, of which it may be only a sub-species, but well characterized by the form of its perichætial bracts, narrowed at apex, and not abruptly subulate from the rounded apex, as is the case in *D. scoparium*. In habit and shape of the leaves it specially resembles the last variety.

DICRANUM MIQUELONENSE. (Florule de l'ile Miquelon, 42.)—In small, compact, yellowish green tufts. Stems dichotomous, radiculose below, 1–3 cm. long. Leaves small, short, erect-imbricate or slightly incurved, oblong-lanceolate, acute or obtuse, concave, entire or minutely sinuate-denticulate at apex, 2–3 mm. long, .50–.75 mm. broad; costa vanishing near the apex, smooth or scarcely rugose at back. Cells of the areolation smooth, small, short, quadrate or irregularly angular in the upper half, rectangular, 1–3 times longer than

broad, thin-walled toward the base, the alar lax, large, quadrate or subhexagonal, brown or yellowish. Fruit unknown.

Miquelon island, on ground and rocks (*Dr. Delamare*).

Rather resembling in habit the stunted forms of *D. elongatum* Schw. and *D. tenuinerve* Zett., but quite distinct by the form and areolation of the leaves. It has also some affinities with *D. flagellare* Hedw.

Fissidens incurvus Schw. var. BREVIFOLIUS.—Leaves broader and shorter; border of the vaginant lamina widening less at base.

Louisiana: on ground in woods near Baton Rouge (*Langlois.*)

TRICHODON FLEXIFOLIUS.—Loosely cespitose, green. Stems erect, simple, short, 2–5 mm. long. Lower leaves small, lanceolate-subulate, the upper larger, patulous, very flexuous, 3–4 mm. long, .35–.50 mm. broad, from an oblong base gradually narrowed into a long linear-subulate, canaliculate, subtubulose point, sinuate at the margins, toothed at apex, and with a broad costa, obscurely excurrent. Cells of the base rectangular, elongated, 2–4 times longer than broad, the others small, quadrate, very chlorophyllose, with transverse walls slightly prominent. Perichætial bracts similar to the leaves, but dilated and subsheathing at base; archegonia 2–4. Male flowers on the same plant below the female, small, gemmiform; perigonial bracts 4–5, the external broadly ovate, suddenly narrowed, cuspidate, the inner broadly and obtusely acuminate, obsoletely costate; antheridia 3–5, subsessile, elongated, with some paraphyses. Fruit unknown.

Florida: on sandy ground, near Beauclerc (*F. C. Sawyer*, 1887).

It is only by the examination of the fruit that we can be certain about the generic position of this species; however, by its vegetative system, it seems closely allied to *T. cylindricus* Sch., from which it differs in the monœcious inflorescence, the gradually narrowed leaves, and the shorter cells of the areolation.

Physcomitrium pyriforme Brid. var. LANGLOISII.—Characterized by the longer-acuminate leaves, the generally longer pedicel (15–20 mm.) and the asymmetrical calyptra, 2–5 lobate at base, but entirely cleft on one side.

Louisiana: Pointe-à-la-Hache, on ground in half-shaded places, growing with the typical form (*A. B. Langlois*). New Jersey: Atco (*H. A. Green*).

WEBERA CARDOTI Ren.—Loosely cespitose, pale green or yellowish. Stems simple, erect, slender, rigid and brittle. Leaves small, erect, imbricate, oblong-lanceolate, decurrent, strongly revolute on the borders, obtuse or subobtuse, rarely subacute, generally sinuate-denticulate at apex, 1–1.5 mm. long, .35–.50 mm. broad; costa very broad, green, percurrent or vanishing very near the apex, widening below and occupying one-third of leaf base. Areolation loose, cells truncate or subattenuate, 2–3 times longer than broad. Pedicel reddish, flexuous, often geniculate at base, 10–15 mm. long. Capsule oblong-subpyriform, symmetric, erect, yellowish or brownish, tapering to an attenuate neck, 2–2.5 mm. long, .35–.75 mm. broad; lid conic. Peristome small, pale yellow, pellucid, very minutely papillose; teeth triangular-lanceolate, long acuminate, provided with 15–25 lamellæ; inner peristome more or less perfect, with split segments and cilia, or reduced to a variously raised and lacerate membrane. Annulus of 2–3 rows of cells. Male plant distinct, smaller; flowers gemmiform, terminal.

Oregon: Mt. Hood, wet sandy rill-banks, growing with *Polytrichum sexangulare* Fl. *(L. F. Henderson)*. Already kindly communicated in 1882 by Mr. L. Lesquereux, but likely from the same collector, who sent to us recently a large and very interesting collection of Pacific coast mosses, including several new species, which we are now describing and drawing for the BOTANICAL GAZETTE.

The *W. Cardoti* is allied to *Pohlia erecta* Lindb., from Norway, but this has the leaves plane on the borders, the costa less broad, vanishing far below the apex, the peristome reddish, etc. *W. commutata* Sch. is also somewhat related to our species, but is at first sight distinguishable from it by its drooping and broader capsule, the convex apiculate lid and the larger peristome.

BRYUM SAWYERI.—Loosely or densely cespitose, green or brownish. Stems short, 10–15 mm. long, radiculose below, branching by several innovations and more or less copiously provided in the upper part with brown, thick, simple, articulate and very caducous filaments, arising from the axils of the leaves. Leaves regularly distant or the upper tufted,

open when moist, erect-imbricate and often slightly twisted when dry, rather concave, oblong-subspatulate, narrowed at base, shortly acuminate, plane on the borders, obsoletely denticulate in the upper part, 2–2.5 mm. long, .5–1 mm. broad; costa percurrent or shortly excurrent. Areolation large, hexagonal. cells 2–4 times longer than broad, thin-walled; at the margins, 1 or 2 rows of narrow, elongated cells, but not forming a distinct border. External perichætial bracts longer, more distinctly bordered, the 2 or 3 inner smaller. Pedicel reddish, 25–45 mm. long. Capsule brown or rufescent, pendent, finally oblique or subhorizontal, defluent into a long attenuate neck, constricted below the mouth after the fall of the convex-apiculate lid. Teeth of the peristome densely trabeculate; segments split; cilia long and appendiculate. The inflorescence seems to be diœcious, the male flowers being unknown.

Florida: Enterprise, on sandy ground and at base of trees (*Fitzgerald*), Beauclerc, on decayed logs (*F. C. Sawyer*). Louisiana: Pointe-à-la-Hache, on wall (*A. B. Langlois*).

This species is readily distinguished from B. capillare, to which it is nearly allied, by its leaves plane on the margins and without distinct border. The brown articulate filaments, which arise from the axils of the leaves and perhaps help the propagation of this moss, are generally very copious on sterile specimens, while they are rare or even wanting on the fertile plant.

Fontinalis antipyretica L. var. Oreganensis.—A remarkable form, with very slender, soft, pinnate stems, yellowish and shining above, not naked below. Stem-leaves distant, open, lanceolate. Branches cuspidate. Branch-leaves erect, imbricate at the top of the branches. Cells of the areolation very long and narrow.

Oregon: top of Coast mountains, in swamps, on the roots of trees. (*Th. Howell*).

Fontinalis Delamarei.—Dull green, stems 15–30 cm. long, naked below, much divided; branches irregularly pinnate, branches erecto-patent, attenuate. Leaves crowded, erect, loosely imbricate, oblong-lanceolate, obtusely acuminate, concave, not keeled, slightly incurved on the borders, 3–4 mm. long, .75–1.25 mm. broad. Cells of the areolation linear-elongated, sometimes rather flexuose, the alar few,

small, subhexagonal. Perichætial bracts often lacerate at the rounded apex. Capsule immersed, oblong-subcylindrical, 2 mm. long, .75 mm. broad; lid conic-acuminate. Teeth of the peristome about .50 mm. long, narrowly linear-acuminate, with 14–20 lamellæ; divisural line distinct at the base only and not perforated. Cilia of the inner peristome united at apex only, the lower transverse bars imperfect, papillose, not appendiculate. Diameter of the spores .025–.028 mm.

On stones in the rivulets of Miquelon island, copiously fruiting (*Dr. Delamare*).—In our work on the flora of the Miquelon island,[2] we indicated this moss as *F. squamosa* L. At that time we knew the plant only from sterile specimens, and in this state it is almost impossible to distinguish it from F. squamosa.

The F. Delamarei is perhaps a sub-species of F. squamosa; it is intermediate between this species and *F. Novæ-Angliæ* Sull., resembling the first by the characters of the vegetative system, and related to the second by the organs of fructification, as far as we can judge from the tab. 65 of the Sullivant's Icones. The original, but sterile specimen of this last species, for which we are indebted to the kindness of our venerable friend, Mr. Lesquereux, differs from our plant in the more slender stems, pinnately branched at right-angles, and in the leaves more distant, not imbricate, characters which give to the plant quite a different facies.

The true *F. squamosa* L., not yet recorded from America, differs from *F. Delamarei* in the following characters: capsule twice as large, ovoid or ovate-oblong, rounded at base; teeth of the peristome twice as long (about 1 mm.), more strongly papillose, more densely trabeculate (26–32 lamellæ); divisural line more distinct and often perforated toward the base; inner peristome perfectly latticed; spores generally a little larger (.028–.031 mm.).

Alsia Californica Sull. var. FLAGELLIFERA.—More slender than the type, with numerous filiform, flagellate branchlets, covered with very small lanceolate leaves.

California: Monterey, on trees (*Miss Martha R. Mann*).

Eurhynchium strigosum BS. var. BARNESI.—Differs from the European type in the stems rather more robust, the stem-leaves larger, longer acuminate, the branch-leaves more

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[2] Florule de l'ile Miquelon, Lyón, 1888.

elongated, obtuse or subacute, and the capsule shorter, broadly ovate.

Idaho: Lake Pend d'Oreille, on logs (*Leiberg*, communicated by Mr. Ch. R. Barnes).

Eurhynchium strigosum BS. var. FALLAX.—Formrobust, resembling in habit E. myosuroides. Stem-leaves very large, triangular-lanceolate, obtuse; branch-leaves rounded at apex. Capsule like that of the typical form.

Idaho, with the preceding.

The type from Europe has the stem-leaves ovate-triangular, suddenly narrowed-acuminate, the branch-leaves lanceeolate, acute or subobtuse and the capsule oblong. It rather resembles in habit E. prælongum or E. Stokesii. This typical form, like the two vars. Barnesi and fallax, has the leaves distant, open or erecto-patent. The forms belonging to the var. *præcox* Wahl. and *diversifolium* Lindb. (*E. diversifolium* BS.)., and which are, at least in Europe, the most widely distributed, have quite a distinct facies, by their concave and closely imbricate leaves and their cylindrical julaceous branches. These forms, which in Europe occur only in alpine and subalpine districts, are met with in low countries of the United States, as the E. diversifolium issued in the *Musci bor. Amer. exsicc.* no. 432 was collected, according to the label, in the hills of Ohio. We have it also from Montana, near Helena (*F. W. Anderson*, communicated by Mr. Ch. R. Barnes).

Plagiothecium denticulatum BS. var. MICROCARPUM.—Differs from the type in its very short and turgid capsule, scarcely 1.5 mm. long, and the thick, flexuous pedicel, often geniculate at base.

Idaho: Kootenai county (*Leiberg;* kindly communicated by Mr. Ch. R. Barnes).

Amblystegium riparium BS. var. SERRATUM.—Plant slender, creeping. Leaves narrow, serrulate at apex.

Kansas: Saline county, roots of trees (*Joseph Henry*).

Amblystegium riparium BS. var. FLORIDANUM.—Very small, appressed. Leaves small, narrowly lanceolate, long acuminate, entire. Capsules short, scarcely 1-1.5 mm. long, arcuate.

On logs, rotten wood, roots and base of trees. Florida (*Garber*). Louisiana, Lafayette's woods (*Langlois*).

HYPNUM SYMMETRICUM.—This plant is a subspecies of *H. uncinatum* Hedw., from which it differs in the less strongly and less regularly plicate leaves, entire or very slightly denticulate, and chiefly in the narrower, erect and quite symmetric capsules, sometimes clustered by two in the same perichætium.

Oregon: On ground, in damp woods (*Th. Howell*). Idaho: Lake Pend d' Oreille, on logs (*Leiberg;* kindly communicated by Mr. Ch. R. Barnes).

Hypnum arcuatum Lindb. var. AMERICANUM (Florule de l' ile Miquelon, 56).—Differs from the typical form in the stems, slender, prostrate, more or less distinctly pinnate and the leaves smaller, with the acumen shorter and broader, blunt and usually denticulate at apex.

Decayed wood and sandy ground. Louisiana; Baton-Rouge, Pointe-à-la-Hache, Riviere-aux-Cannes (*Langlois*).

The type has been collected at Bethlehem, Pa., by E. A. Rau, and the var. *demissum* Sch. near Baltimore by Fitzgerald. This species has been confounded with *H. curvifolium* Hedw., from which it is easily distinguished by the alar leaf-cells, lax, inflated, hyaline and forming distinct auricles.

We will indicate here several species not previously recorded from North America:

Eucladium verticillatum BS.—California: Santa Ana Cañon (*Sam. B. Parish*, kindly communicated by Miss Clara E. Cummings).

Dicranum tenuinerve Zett.—Miquelon island (*Dr. Delamare*).

Fissidens Bambergeri Sch.—Kansas: Saline county (*Joseph Henry*). Louisiana: Point-à-la-Hache (*Langlois*).

Fissidens viridulus Wahl.—Louisiana: St. Martinsville (*Langlois*). Probably confounded with *F. incurvus* Schw.

Trichostomum nitidum Sch.—United States, without locality, collected by *James*, communicated by Mr. Bescherelle.

Bryum microstegium Sch.—Labrador (*Freeman*).

Polytrichum sexangulare Fl.—Oregon: Mt. Hood, sterile (*Henderson*).

Amblystegium porphyrrhizum Lindl.—Miquelon island (*Dr. Delamare*). Kansas: Saline county (*Joseph Henry*).

Amblystegium Kochii BS.—Kansas: Saline county (*Joseph Henry*).

Hypnum Vaucheri Lesq.—Montana: near Helena (*Anderson*, communicated by Mr. Ch. R. Barnes). This species is allied to *H. cupressiforme* L., is quite distinct from the H. Vaucheri of the Manual, p. 414, which is an Eurhynchium (*E. Vaucheri* BS., *Hypnum Tommasinii* Sendtn.).

In Kindberg's *Enumeratio muscorum qui in Groenlandia, Islandia et Færoer occurrunt* (1888), are indicated many species which are not described in the Manual of Lesquereux and James.

Monaco, and Stenay, France.

Explanation of plates XII–XIV.—All figures enlarged more than 15 diameters are copied by means of Nachet's camera lucida.

Plate XII. A. Dicranum sabuletorum. *a a*, entire plant; *b b*, leaves; *c c c*, point of same; *d*, basal areolation; *e*, areolation of the upper part; *f*, external perichætial bract; *g*, inner perichætial bract; *h*, point of same; *i*, capsule and lid.—B. Dicranum Howellii. *a a*, entire plant; *b*, leaves; *c*, perichætial bract; *d*, ditto of D. scoparium.—C. Dicranum scoparium var. sulcatum. *a*, point of a leaf; *b*, capsule; *c*, portion of the capsular membrane, showing the areolation of a longitudinal band.—D. Dicranum Miquelonense. *a*, entire plant; *b b b*, leaves; *c*, point of same; *d*, areolation of the base; *e*, areolation of the upper part.

Plate XIII. A. Trichodon flexifolius. *a*, entire plant; *b*, lower leaf; *c*, upper leaves; *d*, areolation of the base of same; *e*, areolation of the upper part of same; *f*, transverse section of same; *g*, point of same; *h*, perichætial bract; *i*, external perigonial bract; *j*, inner perigonial bracts, showing the antheridia by transparence.—B. Webera Cardoti. *a*, entire female plant; *b*, male plant; *c*, leaves; *d*, areolation of the middle; *e*, areolation on the borders; *f*, capsule; *g*, the same, deoperculate; *h*, portion of the peristome.—C. Bryum Sawyeri. *a*, entire plant; *b b*, leaves; *c*, point of same; *d*, areolation of same; *e*, axillary filaments; *f*, capsule.

Plate XIV. A. Fontinalis Delamarei and F. squamosa. *a*, leaf of F. Delamarei; *b*, capsules of the same; $b^{\times}$, capsule of F. squamosa; *c*, teeth of the peristome of F. Delamarei; $c^{\times}$, ditto of F. squamosa; *d*, portion of a tooth toward the base, F. Delamarei; $d^{\times}$, ditto F. squamosa; *e*, portion of the inner peristome of F. Delamarei; $e^{\times}$, ditto of F. squamosa; *f*, calyptra of F. Delamarei.—B. Eurhynchium strigosum. *a*, stem-leaf of the European type; *b b*, branch-leaves of the same; *c*, capsule of the same; $a^{\times}$, stem-leaf of var. Barnesi; $b^{\times}$ $b^{\times}$, branch-leaves of the same; $c^{\times}$, capsule of the same; $a^{\times\times}$, stem-leaf of var. fallax; $b^{\times\times}$ $b^{\times\times}$, branch leaves of the same. C. Hypnum symmetricum. *a*, entire plant; *b b*, leaves; *c*, capsules.

Histology of the leaf of Taxodium. II.

STANLEY COULTER.

(WITH PLATE XI.)

II. The Mesophyll.—The parenchyma of the mesophyll consists of large, irregular, polyhedral cells, characterized by exceedingly thin walls and numerous infoldings. These infoldings are usually filiform, although in some instances they are somewhat thickened; in others, bifid; in others, terminated by a knob. Those cells nearest the epidermis and the fibro-vascular bundle have, as a rule, the more numerous and prominent infoldings. Scattered throughout this tissue are found the so-called "strengthening cells" (sclerenchymatous), either in groups or singly. They seem to be arranged according to definite plan, as in the foliage leaf of Pinus[10] and the fruit of the Umbelliferæ[11], but may be found in almost any part of the leaf. Sections from different leaves rarely show the same arrangement, and the same holds true of sections from different parts of the same leaf. They may, however, be expected in transverse section with a reasonable degree of certainty in two positions, (1) directly over the fibro-vascular bundle, immediately adjoining the epidermal cells of the outer surface of the leaf, and (2) near the ends of the leaf in its longer diameter. In the first case, they usually occur in groups of from 5–20, either massed or arranged in irregular rows, in which arrangement they often resemble a series of braces for the purpose of support (fig. 4). In the second case, they may appear singly, as a row stretching from the epidermal cells of the outer to those of the inner surface, or as a row running back from the apical cell, in or parallel to the line of the greater diameter of the leaf (fig. 5).

It rarely occurs that in this position these cells are more than three in number, or that they occur otherwise than in a straight line. It sometimes happens that these cells are entirely absent from this region (fig. 3), but this is not frequently the case.

Groups composed of from three to five cells, rarely more, are also found about midway between the epidermis and the fibro-vascular bundle, although these are sometimes wanting. It often happens that one-half of the leaf will be well supplied with these cells, while the other has only one or two,

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[10] Coulter and Rose, BOTANICAL GAZETTE, xi. 258.
[11] Op. cit., xii. 239.

sometimes none. Although following closely no rule, they may roughly be said to occur, if at all, either in a hypodermal layer or layers immediately beneath the epidermis, or in a line about midway between the epidermis and bundle, but never, in either case, forming a continuous ring. In no case in the sections observed have they been found adjoining the bundle. It must be remarked, however, that they are not always found in the positions mentioned, but if present in relatively large numbers, the great proportion of them may be so referred. Apart from these general regions, single cells are found in almost every conceivable position, except adjoining the bundle. They are often found adjoining the respiratory cavities, more often in positions which indicate nothing concerning their function or their relationship to the other leaf tissues.

In transverse section they show the heavily thickened wall and present the peculiar appearance of "fullness," so marked in the case of this tissue in Pinus (figs. 3, 4 and 5).

In longitudinal section they are seen to be elongated prisms with pointed ends (fig. 10), and have the fibrous, banded appearance characteristic of these cells.

Comparing the development of this "strengthening apparatus" of Taxodium with that of Pinus, in which the location of these cells furnishes valuable diagnostic marks,[12] it appears to present the incipient stages of a system which in other sections of the same order becomes highly differentiated. In the imperfect annular arrangement of its strengthening tissue, Taxodium seems to be allied to Taxus on the one hand, and to Abies on the other, and in fact follows the prevailing rule that obtains in most leathery leaves.[13]

In Taxodium, the strengthening cells of the sclerenchymatous type do not surround the resin duct, or even necessarily appear in its region, its support apparently coming from collenchymatous cells, which here at least seem a transition form between the parenchyma and sclerenchyma.

In Pinus, on the contrary, the sclerenchymatous strengthening tissue seems to reach its highest development in its annular investment of the resin ducts, an investment which in Pinus sylvestris is in every instance complete and in some cases consists of two layers (cf. figs. 11, 12 and 13).

The strengthening apparatus of Taxodium distichum differs therefore from that of Pinus sylvestris in the following particulars: (1) In the absence of the continuous hypoder-

[12]Coulter and Rose, BOTANICAL GAZETTE, xi. 258.
[13]De Bary, Comp. Anat. of Phan. and Ferns, 419.

mal layer, which in Pinus seems collenchymatous rather than sclerenchymatous; (2) in the presence of this tissue in the median region between the epidermis and bundle; (3) in its absence at the resin duct; (4) in their indeterminate position.

In fact, so widely variant is the system in Taxodium itself, that it is only through an examination of some hundreds of sections that even an approximate disposition is to be found.

So far, therefore, as the strengthening apparatus is concerned, the leaf of Taxodium seems much less perfectly developed than that of Pinus.

Between the bundle and the epidermis of the lower leaf surface, relatively close to the latter, is found the single resin duct. The position is that to be expected from the nature of the leaf as shown by Thomas in Vergl. Anat. der Coniferen-laubblätter. No accessory passages are found in any other portion of the leaf. In transverse section the duct is seen to be somewhat irregular in outline, more nearly polyhedral than circular. The bounding cells, as above said, seem to be collenchymatous, and differ only in their thickening from the surrounding parenchyma. Those cells lying between the epidermis and the duct are the most heavily thickened, and by their arrangement furnish not only support but protection.

On the upper side of the duct the collenchymatous cells shade down gradually as to thickness of wall, until they reach the bundle. The duct thus seems to be perfectly supported and protected in the vertical line.

No marked extension of the thick-walled bounding cells is to be found laterally; they seem in that direction to pass somewhat abruptly into the typical parenchyma of the mesophyll (figs. 4 and 11).

The secretory cells of the duct, generally six in number, show in transverse section a marked difference in size and form. In size, they often differ as four or five to one, while their forms range from irregularly triangular, through narrowly elliptical to oval (fig. 11).

In median longitudinal section they are seen to have their longest diameter in the direction of the duct, while the bounding cells, which show numerous infoldings, have a relatively similar arrangement (fig. 10). The walls of the secretory cells are extremely thin and delicate, showing no thickening in any direction.

No tests were made to determine the nature of the con-

tents of the cells, and they are classed among the resin secreting cells because of their similarity in structure and arrangement to the typical resin ducts, and the close relationship of Taxodium to resin secreting plants.

The resin duct of Taxodium, when compared with the secretory system of Pinus sylvestris, appears remarkably rudimentary. Leaving out of view the greater number of ducts found in Pinus, a comparison of the duct of Taxodium with a single duct of Pinus confirms us in the thought that we have in the former the beginnings of a system, which is fully and strikingly developed in the latter. In Pinus we find in transverse section the almost perfectly circular outline of the duct, the sclerenchymatous investing ring at times of double thickness, the more numerous and regular secretory cells often of more than one layer, evidencing in every case a complete differentiation from the surrounding tissues, and an apparently perfected system.

In Taxodium, on the contrary, the whole duct gives evidence of an incomplete differentiation. It agrees more nearly in every particular with the duct of Pinus sylvestris as found at the commencement of its development in the young leaf (cf. figs. 11 and 12).

In this system, then, as well as in the cases of the stomata and the strengthening cell system, the leaf of Taxodium gives evidence of a much less complete development than that of Pinus.

III. Fibro-vascular system.—The fibro-vascular bundle[14] follows the general rule which obtains among the Coniferæ in having a separate course and free end, and also accords with the condition, so far as it has been investigated, among the Cupressineæ, in being single and median. While the bundle, which is of the collateral type, in transverse section, at first glance, seems to stand out sharply and distinctly, it is a matter of some difficulty to assign to it a definite limit, there being no bundle sheath and the parenchymatous elements of the surrounding tissues passing gradually into those which lie within the bundle itself. The orientation of the bundle is normal. Toward the end it is tapered somewhat, though not sharply. The xylem, which is irregularly semi-crescentic in shape, diminishes as it extends toward the upper leaf surface, until at its limit it consists of but two or three rows of tracheides. These, however, are in immediate contact with

[14] Geyler, Gefässbundelverlauf in d. Laubblattregion d. Coniferen, Pringsheim's Jahrb. VI., 55; Thomas, in Pringsheim's Jahrb. IV., 43; Cf. also, de Bary, Comp. Anat. of Phan. and Ferns, 300.

a series of heavily thickened cells, apparently collenchymatous, by which the bundle seems to be directly connected with the group of hypodermal sclerenchymatous cells heretofore described.

The xylem also diminishes laterally in the same manner, and is connected on either hand with an irregularly curved line of tracheides which project into the surrounding parenchyma. The line of the "fringe of tracheides," if, indeed, it can be called a fringe, can not be said to follow the contour of the leaf. In many cases it terminates abruptly, although in one or two instances in the sections made it was a prominent feature. Its presence, however, was not so constant, nor so marked, as might have been expected from the studies of Frank[15], and later those of Mohl[16]. In other respects the xylem seems in no wise different from that usually found in collateral bundles among gymnosperms.

The phloem, which shows regular rows of similar elements, in all the sections examined, seemed to have thicker walls than were to be expected in this section, but it is probable that the apparent thickness was due to swelling. In spite, however, of this somewhat unusual thickness of the membranes of the phloem, the boundaries between it and the xylem are sharp and distinct.

The phloem, as the xylem, diminishes somewhat laterally, and aids in giving the pointed appearance to the bundle in cross section.

As the xylem is connected by a series of thickened cells to the sclerenchymatous strengthening cells above it, so the phloem is connected with the resin duct by a number of rows of thick-walled cells, and thence by way of the collenchyma surrounding the duct, to that lying between the duct and the epidermis. In the vertical line from the phloem to the duct and thence to the lower leaf surface, the thickness of the cell walls seem unchanged, but in all other directions they diminish somewhat rapidly until they pass into the surrounding parenchyma. It is, as stated at the first, extremely difficult to say where the bundle ends, and the non-equivalent elements of the same form begin (figs. 4 and 2).

In longitudinal vertical section, the elements of the bundle present no marked features unless it be in the absence of spiral vessels, which were not detected in any of the sections made. I am not as yet prepared to say that they do not oc-

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[15] Botan. Zeitung, 1864, p. 167.
[16] Ibid, 1870, p. 10.

cur, but they certainly are not so prominent or numerous as in Pinus and the other Coniferæ studied (fig. 10).

While the bundle is single and median, it has in some measure the appearance of having been formed by the coalescence of two bundles. If this be true, the coalescence occurs in the node, or immediately at the attachment of the leaf to the branch. Careful sectioning of the entire leaf failed to demonstrate the fact. In the work, I have as yet been unable to secure satisfactory sections either through the node, or through the exact base of the leaf. The point is therefore undetermined, with the probabilities, however, strongly against the view of the bundle being the result of a coalescence of two bundles.

The space occupied by the bundle, as compared with the other tissue systems making up the leaf structure, is smaller than is usually the case in conifers, much smaller than in Pinus sylvestris.

In comparing the fibro-vascular systems of Taxodium and Pinus, we find, as in the case of the other parts compared, a much less sharp differentiation from the non-equivalent surrounding elements, as well as a less complete development of the composing elements (cf. figs. 2 and 4 with fig. 13). It may therefore be safely concluded that, so far as leaf structure is concerned, Taxodium distichum presents a much less complete development and a much lessperfect differentiation of systems than is found in Pinus sylvestris. The facts in support of this view may be summarized thus:

1. In the less perfect mechanism of the stomata, evidenced by (a) the character of the guard cells, and (b) the slight modification of the subsidiary cells.

2. In the imperfect development and indefinite arrangement of the strengthening apparatus, shown by (a), the absence of the continuous hypodermal layer, (b) the absence of sclerenchyma from the region of the resin duct, and (c) the presence of single cells and groups of cells of this tissue, at indeterminal points in the mesophyll, referable to no theory of support.

3. In the presence of a single resin duct, showing (a) less regularity of form, (b) few and irregular secreting cells, and (c) imperfect differentiation from the surrounding tissues.

4. In the less complete differentiation of the bundle and the less perfect development of the elements composing it.

In all of these particulars, indeed, it more nearly resembles the conditions found in the young foliage leaf of Pinus

sylvestris than in the adult leaf. It may, therefore, be fairly regarded as showing the beginnings of a series of mechanisms and systems which in Pinus sylvestris have reached a high development. In Taxodium we find these variant in form, in position, in development; in Pinus, constant in all these particulars.

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EXPLANATION OF PLATE XI.—The magnification figures were upon the original drawings. These having been reduced one-half, the magnification figures must be correspondingly reduced.

Fig. 1. A. Single leaf of T. distichum in position. B. Leafy branchlet, with its crowded, 2-ranked, linear leaves.

Fig. 2. Cross section of leaf of T. distichum, showing the three regions of which the leaf is composed, distribution of strengthening cells, and position of resin duct.

Figs. 3, 4, and 5. Same, more highly magnified, showing also distribution of stomata. The three figures, as can be readily seen, are parts of the same section.

Fig. 6. Surface slice of T. distichum, showing irregular outlines of epidermal cells and depressed position of stomata.

Fig. 7. Section of stoma of T. distichum, showing depressed position, oval guard cells with heavily thickened outer walls, and large respiratory cavity.

Fig. 8. (Letter press, p. 80) Section of stoma of Pinus sylvestris.

Fig. 9. Longitudinal section, leaf of T. distichum, showing formation of apex of leaf by a continuation of epidermal cells of inner surface and modification of adjacent cells.

Fig. 10. Median vertical longitudinal section, leaf of T. distichum. *s*, superior surface; *i*, inferior surface; *st*, strengthening cells; *r*, resin duct.

Fig. 11. Resin duct of T. distichum, showing imperfect differentiation from surrounding tissues and irregular thin-walled secretory cells.

Fig. 12. Resin ducts of Pinus sylvestris.

Fig. 13. Transverse section of foliage leaf of Pinus sylvestris, showing the three leaf regions, distribution of strengthening cells and position of resin ducts.

BRIEFER ARTICLES.

A modification of the versatile anther.—In the genus Lilium, for example, it is a well-known fact that the anthers are at first erect, but as they mature the true versatile character becomes evident. An inspection of a young anther shows that the upper portion of the filament is slender, and inserted, or held in position, between the two lobes of the

anther. A little force applied in the right direction will cause this small and somewhat tapering portion of the filament to leave the canal, and the heavy anther is then suspended at the middle by the tip of the filament. By careful manipulation the original position can be restored and the anther is again upright. The release of filament takes place naturally as the two lobes dehisce and separate from each other.

In a very closely related genus, namely Tulipa, the stamens are also large, but the anthers remain upright throughout their whole existence. When the tulip stamen matures and the pollen is exposed along the two sutures, the flat anther has a twist in it so that the widest diameter at the tip stands at right angles to that of the base. Owing to its large size, its breadth and narrowness, and peculiar attachment to the filament, the anther may be turned upon its long axis by any slight breeze or by the bodies of visiting insects. This attachment is a long pivot which extends upward in the center of the anther for a distance and is held in place by tough fibres at its tip. So elastic is this tip that the anther may be turned several times upon its long axis before it will become detached from the hard peg-like extremity of the filament.

The structure for facilitating the dispersion of pollen in the tulip anther is not unlike what it would be in the lily if, instead of becoming strictly versatile, the filament tip was continued in its "pocket" and the anther was free to turn upon this upright point.—BYRON D. HALSTED, *Rutgers College.*

The winter leaves of Corydalis glauca and C. flavula.—Says Curtis (*Bot. Magazine*, 1792) referring to the Linnæan *Fumaria sempervirens*: "The term *sempervirens* originated in the description of it given by Cornutus (*Fumaria siliquosa sempervirens* Cat. Canad. 57 t. 57); the impropriety of calling an annual plant an *evergreen* has appeared to us too glaring to be continued; we have thought the promotion of science required a change in the name, and have therefore altered it to that of *glauca*." When Pursh removed the plant to *Corydalis* he made it *Corydalis glauca*. As an author who places an old species in a new genus is not bound under the canons to retain the old name, it may be in order for those who sympathize with Curtis's reasons for changing the Linnæan name to give it another, for *glauca* is no more characteristic than *sempervirens*. Certainly some forms of *C. aurea*, especially Rocky Mountain forms, are more glaucous than forms of *C. glauca* ever are. If we may change names because they are not in accord with the terms used in describing the plant, how will the list of synonyms swell!

The object of this note is to suggest whether, after all, Cornutus might not have more reason than Curtis supposed for using the term *sempervirens* in connection with this plant. Last January I spent the greater part of a day among the pine-crowned hills of the Allegheny range, near Lewistown in Central Pennsylvania. It had not been much

below the freezing point at night, and the day was a pleasant one for studying the root-leaves of plants—to me an interesting department of phytology. It was a pleasure to discover a new Pennsylvania locality for *Pinus pungens*, but a much greater was furnished by a complete carpet of glaucous green leaves of a *Corydalis*, spread over the moss-covered mass of rotting pine needles under the trees. As the allies of the plant, as known to our botanical grandfathers, died completely down in winter, why should it be wondered at, and made censurable, that such a plant should be dubbed evergreen?

Taking a few plants home and subsequently flowering them, it proved to be *Corydalis flavula* of DC. (*Fumaria flavula* Rafinesque). I have never met *C. glauca* in winter excursions, but its near relationship to this species would justify some faith in Cornutus having seen something similar suggestive of the name.

C. flavula is certainly an annual in the sense of germinating and dying within a twelve month, but in the sense some use the term biennial, that is, getting considerable strength in the autumn after germinating early in the season, and then remaining over to the next to finish its growth and mature, it would not be an annual in Curtis's estimation, nor probably would *C. glauca* be in its native wilds.—THOMAS MEEHAN, *Germantown, Pennsylvania.*

Pollen mother-cells.—If any person has experienced difficulty in obtaining pollen mother-cells in excellent condition for study, their attention is called to the young anthers of *Negundo aceroides* Moench. Sections of thecæ may be easily obtained by cutting across the staminate flowers before they have attained half their full size. When these sections are not too thin the thecæ will be found made up of a single whorl or circle of mother-cells, many of which are pear-shaped, due to unequal pressure. The mother-cells in the center of the thecæ easily become detached and may be found scattered through the liquid in which the sections are immersed. These loose cells have a strong resemblance to the asci of the Erysipheæ (powdery mildews), and the four pollen grains may be found in all stages of development. In the beginning there is only the slightest differentiation of the protoplasm into four indistinct masses. As they become more manifest the arrangement of the four is found inconstant. Sometimes they are placed with their longer diameter parallel like the four nutlets in a borrage fruit. In others two are in the same plane and the other two above or below, and at right angles to the first pair. Azorubin is excellent in weak solution for bringing out the young grains more prominently. The pollen grains do not use up the thick mother wall, and leave pits or cavities as they escape, as young seeds in a wax-bean pod.—BYRON D. HALSTED, *Rutgers College.*

CURRENT LITERATURE.

Revision of Umbelliferæ.[1]

Botanists everywhere, and American botanists especially, owe a large debt of gratitude to Professors Coulter and Rose for the above work, now issued in its completed form. No order of our plants has been more difficult or was in greater confusion; and this, of late years, had been vastly increased by the many and often incomplete specimens of new far western species. The authors, at the beginning of their labors, wisely determined to study the better known and less difficult species of the eastern states first. The revision of these was completed and issued in 1887, and to it was appended an excellent paper on the "Development of the Umbellifer fruit." In the present issue is given a brief "Historical Sketch" of the bibliography of the subject and a good account of the geographical distribution of the species, with a statistical table appended. The vegetative organs, the inflorescence and the flower then receive attention, and then follows the final result of their studies of the fruit and its development. This introduction, as it were, to the systematic portion, closes with some notice of the "characters used in classification," and some pertinent "directions for collection and study." The first is especially interesting because of our authors' low estimate of the oil-tubes of the fruit as a divisional character. They do not use it in the primary divisions and even in the subdivisions it is put almost last in diagnostic importance The "strengthening cells" under the ribs of the fruit of many species also receives marked and deserved attention.

Next comes the "Systematic Synopsis of the Genera" (with an "Artificial Key to the Genera"), and the "Systematic Synopsis of the Species." The former begins with the Caucalineæ, thus reversing the usual order. The first series comprises those genera, the fruit of which have the secondary ribs most prominent; but as this contains but 5 of the 59 genera and only as many species, it is the arrangement of the second series containing the remainder of the genera (those having the fruit with primary ribs only) which principally concerns us. The primary divisions are three; those genera whose fruit is strongly flattened dorsally (17), those whose fruit is not flattened at all or but slightly (11), and those with laterally flattened fruit (31). The relative strength is better shown by saying that of indigenous species the first division contains 87, the second 35, and the third 91. This arrangement leaves the sequence of genera much as we are accustomed to see it, except as before stated—a notable exception being the placing of Erigenia next to Hydrocotyle. There are 5 new genera, and 3 other genera, not heretofore recognized as represented in our flora, are admitted.

[1] COULTER, JOHN M., AND ROSE, J. N.—Revision of North American Umbelliferæ. 8 vo. pp. 144, with nine plates. Crawfordsville, Ind. December, 1888. $1.00.

In the "Synopsis of Species" is found the same careful and discriminating work. Following Bentham and Hooker, Archangelica is merged in Angelica, which contains sixteen species. *Archangelica Gmelini* DC. of the northern coasts becomes *Cœlopleurum Gmelini* Led. The Colorado plant, so named, becomes *Selinum Grayi*, and this genus of seven species also includes those specimens from the northwest formerly referred to *Conioselinum Fischeri*, here divided between *S. Benthami* Wats. and *S. Hookeri* Wats. Conioselinum is again restored for *C. Canadense* T. & G. Tiedemannia is restored and includes Archemora, which thus disappears from our flora; in this the author's views are doubtless correct, as they are also in separating this genus (and Pastinaca) from Peucedanum, to which Bentham and Hooker joined them. A new genus, *Coloptera*, is formed by bringing together three species which have been variously referred to Cymopterus, Ferula and Leptotænia. To the last-named genus are again referred the species removed to Ferula by Drs. Gray and Watson, and this name also disappears. The dominating genus is Peucedanum, now increased to forty-three species, all belonging to the trans-Mississippi region. Of these the authors have contributed fourteen. In these nearly allied and somewhat difficult genera there is room for difference of opinion, but we apprehend that our authors have done very much to settle the proper relations of the genera and species. Other interesting new genera are *Pseudocymopterus*, a good genus containing *Thaspium ? montanum* Gray and two species formerly referred to Cymopterus; *Museniopsis* for *Tauschia Texana* Gray; *Harbouria* instituted for *Thaspium trachypleurum* Gray; and *Aletes*, also of a single species, which has a most curious history, well illustrating the former confusion of the order. *Oreoxis humilis* Raf. takes the place of *Cymopterus alpinus* Gray. *Podistera Nevadensis* Watson is retained for *Cymopterus Nevadensis* Gray. Eulophus is taken to include *Podosciadium* Gray. Our only native Bupleurum is well separated from *B. ranunculoides* L. under the name of *B. Americanum*. *Velæa* DC. is again separated from Arracacia and the species of Deweya are merged in it, and the name which commemorated the labors of a worthy botanist is dropped.

An admirable feature of this part of the work is to be found in the clear diagnostic notes in which the authors give their reasons for the formation of new genera or the re-arrangement of the species.

The excellent figures of cross-sections of the fruit are placed at the end of the work. There is also a good index, which is curiously interposed between the "list of figures" and the figures themselves.

This work, the authors say, is the result of "some four years of unremitting study." It has been time well spent for their own fame as well as for the advantage of botanists at large. They have brought to their work improved methods of study instead of relying wholly upon external characters, and have thereby advanced the grade and standing of systematic botany.—Wm. M. Canby.

Development of Pilularia.[2]

In undertaking the study of this interesting plant Dr. Campbell had in view two things, viz.: the investigation of its life-history, and the determination how far the parrafin imbedding-process was of practical application in the study of vegetable embryology. The method of imbedding was found eminently successful, and, as a consequence, the life-history of Pilularia is worked out as it never has been before. The material was kept in constant germination and the investigation was a most exhaustive one. The subject is treated under the following captions: the microspores and male prothallium, the macrospore and female prothallium, the embryo, the leaf, the root-quadrant, the stem-quadrant, the foot-quadrant, the structure and division of the nuclei in the embryo, subsequent growth of the young plant, and the relationships of the Marsiliaceæ. The study of the microspores is especially interesting, as the author succeeded in removing the exosporium and following the development of the prothallium and antheridium with great precision. The characters of these structures are much more nearly those of the true ferns than has heretofore been supposed. In reference to this relationship the author says: "Botanists have long recognized the evident relationship of the Marsiliaceæ to the true ferns, especially to the Polypodiaceæ, and this view is strengthened by the very great resemblance in the structure of the antheridium. Whether a more complete knowledge of Salviniaceæ will show further relationships between them and the Marsiliaceæ is doubtful, for apart from both families being heterosporous, they have little in common."

The Families of Plants.

Engler and Prantl's magnificent work[3] has just reached the end of the second volume, the first one completed. It makes a book of 1024 pages, and contains 803 illustrations, which are made up of 3537 separate figures. These illustrations are not only abundant, but are of the finest execution. The work must be of immense service to botanists, and the low price of the parts places it within the reach of all. The various parts have been noticed in this journal, but with the conclusion of the volume it is a fitting time to note the contents. The orders presented are as follows: Alismaceæ (Buchenau), Amaryllidaceæ (Pax), Aponogetonaceæ (Engler), Araceæ (Engler), Bromeliaceæ (Wittmack), Burmanniaceæ (Engler), Butomaceæ (Buchenau), Cannaceæ (Petersen), Centrolepidaceæ (Hieronymus), Commelinaceæ (Schönland), Coniferæ (Eichler, Engler, Prantl), Cordaitaceæ (Engler), Cycadaceæ (Eichler, Engler, Prantl), Cy-

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[2] Campbell, Douglas Houghton.—The development of *Pilularia globulifera* L. [Reprint from Annals of Botany, Nov. 1888, pp. 233–264, with three plates.]

[3] Engler A. and Prantl, K.—Die natürlichen Pflanzenfamilien nebst ihren Gattungen und wichtigeren Arten insbesondere den Nutzpflanzen; bearbeitet unter Mitwirkung zahlreicher hervorragender Fachgelehrten. II Teil in sechs Abteilungen. Mit 3537 Einzelbildern in 803 Figuren, 3 Vollbildern, sowie Abteilungs-Registern. Leipzig: Wilhelm Engelmann. 1889.

clanthaceæ (Drude), Cyperaceæ (Pax), Dioscoreaceæ (Pax), Eriocaulaceæ (Hieronymus), Flagellariaceæ (Engler), Gnetaceæ (Eichler), Gramineæ (Hackel), Hæmodoraceæ (Pax), Hydrocharitaceæ (Ascherson, Gürke), Iridaceæ (Pax), Juncaceæ (Buchenau), Juncaginaceæ (Buchenau, Hieronymus), Lemnaceæ (Engler), Liliaceæ (Engler), Marantaceæ (Petersen), Mayacaceæ (Engler), Musaceæ (Petersen), Naiadaceæ (Magnus), Orchidaceæ (Pfitzer), Palmæ (Drude), Pandanaceæ (Graf zu Solms), Philydraceæ (Engler), Pontederiaceæ (Schönland), Potamogetonaceæ (Ascherson), Rapateaceæ (Engler), Restionaceæ (Hieronymus), Sparganiaceæ (Engler), Stemonaceæ (Engler), Taccaceæ (Pax), Triuridaceæ (Engler), Typhaceæ (Engler), Velloziaceæ (Pax), Zingiberaceæ (Petersen).

Minor Notices.

MR. A. P. MORGAN has distributed the first part of a paper upon North American Gastromycetes, published as a reprint from the *Jour. Cin. Soc. Nat. Hist.* The present part presents the 5 genera of Phalloideæ, accompanied by a colored plate of a new Mutinus. The next part will begin the Lycoperdaceæ. As an outline of the work the author states that the five orders of Gastromycetes are represented by genera as follows: Phalloideæ 5, Lycoperdaceæ 10, Sclerodermaceæ 7, Hymenogastraceæ 6, Nidulariaceæ 5.

THE REPORT of the botanist, Mr. Chas. H. Peck, of the New York State Museum of Natural History,[4] for the year 1887, was issued a short time ago, something over a year late. Fifty-two new species are described, all but two being Hymenomycetes. Altogether over a hundred species are added to the list already reported as belonging to the state flora. A very useful index of genera and species contained in the twenty-second to thirty-eighth reports is given. A paper on fungi destructive to wood, by Mr. P. H. Dudley, with four illustrations, is also included.

NO MORE IMPORTANT botanical contribution from the experiment stations has yet been published than the bulletin on "root rot of cotton or 'cotton blight,'" by Prof. L. H. Pammel.[5] The author found himself at the outset confronted with a subject on which almost nothing had been written, and regarding which there was great diversity of opinion. He has carefully considered the prominent views, but after a full study of the diseased plants concludes that the disease is due to an injury of the roots by a fungus mycelium. It also affects sweet potatoes.

[4] PECK, CHAS. H.—Report of the botanist. (41st Annual Rep. St. Mus. Nat. Hist., for 1887, pp. 49–122.) 8vo. Troy Press Co., 1888.

[5] PAMMEL, L. H.—Root rot of cotton or "cotton blight." (Texas Agricultural Experiment Station, Bulletin No. 4.) 18 pp., 8vo. Houston, 1889.

NOTES AND NEWS.

O. A. FARWELL, of Clifton, Mich., reports the rediscovery, in Michigan, of *Salix balsamifera* Barratt.

THE HERBARIUM of the Agricultural Department is to be transferred to the care of the Smithsonian Institution. The botanist of the department is to be curator of the herbarium.

SOMETHING of the uncertainties of British Hieracia may be inferred from the fact that in the last *Journal of Botany* (March) Mr. Frederick Hanbury describes four new species from that well explored country.

Dr. S. O. LINDBERG, Professor of Botany and director of the botanic garden of the University of Helsingfors, a most distinguished and acute bryologist, died on the 20th of February after a short illness, in the 53d year of his age.

DR. J. B. DE TONI, of Venice, proposes to issue a Sylloge Algarum containing descriptions of all known species of algæ, and thus do for chlorophyllous thallophytes what Prof. Saccardo in his Sylloge Fungorum has done for those without chlorophyll.

MR. JOHN DONNELL SMITH has just issued an enumeration of the Guatemala plants, upon which he has been at work for the past two years. His distribution will be deferred until his return from Guatemala, for which country he sailed from New Orleans March 21.

THE BOTANICAL SOCIETY of Western Pennsylvania, located at Pittsburgh, has issued a neat calendar, containing a list of meetings, objects of the society, officers, and members. It can be had by addressing the Corresponding Secretary, Mr. J. D. Shafer, 159 Fourth avenue.

MR. JAS. M. MACOUN has published a handsome check-list of the vascular plants of Canada. It is based upon Prof. John Macoun's catalogue, but includes material that has been discovered or revised since the publication of that excellent work. It can be had for 50 cents, by addressing the author at Ottawa, Canada.

THE *Deutsche botanische Monatsschrift* has begun the publication of a news column, which its readers will doubtless find a welcome addition, even if it does not meet a deeply felt want in the German economy, as it most assuredly does in this country. We notice items referring to America and Australia, as well as to Germany.

PROFESSOR ERNST RUDOLPH VON TRAUTVETTER, author of a large number of papers on the Russian flora, died at St. Petersburg, January 24, 81 years of age. He was director of the St. Petersburg botanical garden from 1866 to 1875. A genus of American plants belonging to the Ranunculaceæ has been dedicated to him.

WE WOULD call attention to the collection of the late Rev. Joseph Blake, which is now offered for sale. It is nearly all mounted, is in excellent condition, and contains many of the plants of our oldest and best collectors. It contains nearly 2,500 species of United States plants, besides good sets from many foreign countries. Further information will be found upon our advertising pages.

Notes on North American Willows. IV.

M. S. BEBB.

1. SALIX ARCTICA Pallas. Flora Rossica, vol. 1, pt. ii, p. 86. *S. crassijulis* Trev. ex Traut. Sal. frigid. p. 308. *S. diplodictya* Traut. l. c. p. 307. *S. Pallasii* Anders. DC. Prod., vol. 16, pt. ii, p. 285.

2. S. BROWNII. *S. arctica* R. Br. Bot. Ross Voy. 2 ed., vol. 2, p. 194. Melv. Isl. Pl. p. cclxx, 11 (not Pall.). Hook. Fl. Bor.-Amer. ii, p. 152. Ledebour, Fl. Ross. ii, p. 86. Icon. Fl. Ross. Tab. 460. Anders., DC. Prod., 16. 2. 286 (excl. var. *nervosa*).

Salix arctica Pallas was published in 1788. The species is a very peculiar one, of striking features, easily recognized, and the description given is graphic and wholly free from ambiguity. In the Botany of Ross' Voyage, London, 1819, Robert Brown printed in a list as a new species his *S. arctica*, the description of which was published in the *Chloris Melvilliana*, List of Plants collected in Melville Island under Capt. Perry, London, 1823. The earlier *S. arctica* of Pallas appears to have been unknown to Brown; at any rate he makes no reference to it. With the exception of Ledebour, who misapprehended *S. arctica* Pall., and united with it as a synonym *S. arctica* R. Br., the fact came to be recognized by well informed botanists that the name *S. arctica* had been given to two distinct species. Both names continued to be sustained, one by its manifest priority, the other by the preponderating authority of Robert Brown. The species were distinguished in each instance by citing one author and excluding the other. Thus it was *S. arctica* Pall. (not R. Br.) or *vice versa*, *S. arctica* R. Br. (not Pall.) This state of things continued unchanged down to the time when Andersson's revision of the entire genus for De Candolle's *Prodromus* precipitated the suppression of one or the other of the two names. The older species now received the name of *S. Pallasii* And., and the authority of Pallas was carried over and imposed upon *S. arctica* R. Br. *S. arctica* Pallas became *S. Pallasii* n. sp., and *S. arctica* R. Br. became *S. arctica*

Pall.; the two species (aside from the shifting of names) standing in the same relation precisely as heretofore. Had *S. arctica* Pall. been written down a synonym of *S. Pallasii*, and *S. arctica* R. Br. been left intact, some degree of consistency could be urged in behalf of an author who throughout pays little or no regard to claims of priority. It might be argued that *S. arctica* R. Br. was so deeply embedded in the science that it could not and ought not to be torn out by the roots, and that it were better, since one of the two names must be suppressed, that the more obscure—even if confessedly the older one—be sacrificed. Any such apology, however, is felt to be out of place when we have a new name given to the old *S. arctica* Pall., the authority of Pallas trans ferred to a species of which he was entirely ignorant, and Robert Brown left out entirely.[1]

But we are not obliged to rest our judgment solely upon the characters given, though in the present instance this evidence is in itself conclusive. Not only does the name, *S. Pallasii*, imply the earlier description by Pallas, but we have *Andersson's own admission* that he had seen the specimens of Sujef (type of *S. arctica* Pall!) "in the herbarium of Pallas, inscribed *S. arctica*," and that these did not differ from his *S. Pallasii*, var. *diplodictya!*

The venerable Dr. Trautvetter, whose special study of arctic willows and whose familiarity with the work done on Salix by Russian botanists, must combine to give his opinion a weight beyond that of Andersson's, writes in a letter: "*S. diplodictya* differs from *S. crassijulis (S. arctica* Pall. not R. Br.), only in the leaves green and shining beneath, and it may be questioned if the species is well founded." Here, in a brief sentence, we have the pith and substance of the

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[1]*S. arctica* Pall.	*S. Pallasii* et *a. crassijulis* And.
"Folia pro planta majuscula	"Folia supra medium
pollice latiora,	pollice latioribus,
obovata,	obovatis,
apice latiora rotundata,	apice rotundatis,
integerrima,	integerrima,
crassius reticulata,	distincte reticulato-nervosis,
subtus tenuissime villosa,	subtus sericeis,
amenta fœminea magna bipollicaria, digiti minimi crassitie	amentis femineis fere bipollicaria, crassiusculis,
e lateribus ramorum,	lateralibus
longius pedunculata duobus,	pedunculo superne sat
tribusve foliis majusculis	longe nudo inferne
stipata,	foliis 2–3 instructo,
capsulæ conicæ,	capsulis conicis,
tomentosa-canæ." Flora Rossica.	longe cinereo villosis." DC. Prod.

"Capsulæ confertæ," Pall., and "amentis densifloris," And.—meaning the same—could not be conveniently arranged opposite each other in the schedule.

Pallas died 1811, twelve years before *S. arctica* R. Br. (based upon specimens brought home by British explorers) was published.

whole matter. 1, That *S. diplodictya* is not distinct from *S. crassijulis;* 2, that *S. crassijulis* is synonymous with *S. arctica* Pall. (which is the main point); and finally, 3, the familiar assertion that the *S. arctica* of Pallas *is not* the *S. arctica* of Robert Brown—a statement which can not be made too emphatic, in view of the placid acquiescence, for years past, in the dictum of Andersson to the contrary.

It is to regretted that a name grown so familiar as that of *S. arctica* R. Br. must needs be disturbed; on the other hand, *the open fact of the priority of S. arctica Pall. can not be ignored*, and as what Sir William J. Hooker was wont to call "Mr. Brown's S. arctica" was only sustained by the constant mention of the name of the distinguished author, let us hope that the substitution of this name for the one preoccupied may in a large measure preserve unbroken the old associations.

Rockford, Ill.

The Diatom marshes and Diatom beds of the Yellowstone National Park.

WALTER H. WEED.

It is well known that the minute algæ, to which the name of diatoms has been given, possess, in a remarkable degree, the power of separating silica from solution in the waters in which they live. This action is the more remarkable because the silica is often present in such exceedingly small amounts that an almost inconceivable activity on the part of the plant is required to obtain an adequate supply to form their frustules, while the separation of the silica must itself be referred to some vital force exerted by the plant during its growth. It is this action which gives to this low form of life its importance as a geological agent.

As the Diatomaceæ exist under very diverse and extreme conditions of environment, occurring in the icy waters of polar seas, the heated currents of the tropics, and even in the almost boiling waters of hot springs, they are in consequence the most widely distributed form of life known, and their common occurrence in ponds and ditches is well known to every microscopist. Nevertheless, contemporaneous deposits formed of their remains are usually small in comparison with

the immense beds of Tertiary age, which occur in many parts of the world.

In the prosecution of geological work in the Yellowstone National Park, the writer has found that diatom beds of recent origin cover many square miles in the vicinity of the geyser and hot spring basins. These deposits, which are among the largest fresh water diatom beds of contemporary age known, are still forming by the growth of diatoms in the warm water marshes supplied by the hot spring waters.

These diatom marshes are sure to be remembered by all who may attempt to cross them, for the treacherous surface and apparently bottomless depths of the ooze offer an effectual barrier to any progress in that direction.

Near the Emerald springs at the Upper Geyser Basin of the Firehole river, the most noted geyser region of the park, there is a typical marsh of this character. The waters have in times past encroached upon the neighboring patch of timber, killing the pines (Pinus Murrayana), whose bare, gray trunks stand upright in the ooze or lie scattered about half immersed beneath the waters of the marsh. A subsequent partial recession of the water has left a bare, white strip between bog and wood, on which vegetation has as yet a feeble hold, and the gaunt poles of the dead pines stand in a white powdery soil that is evidently a dried portion of the marsh mud. A large part of this bog is covered with a sparse growth of brackish water plants, and the drier parts are grass grown and form a fairly firm meadow bottom. The greater portion consists, however, of a semi-liquid, greenish gray, dirty looking ooze. Under the microscope this was found to consist of beautiful siliceous tests of various species of diatoms. Samples of this material, which Mr. Francis Wolle has kindly examined for me, were found to contain the following species:

Denticula valida	**Epithemia hyndmannii**
" elegans	**Cocconema cymbiforma**
Navicula major	**Achnanthes gibberula**
" viridis	**Mastigloia smithii**
Epithemia argus	**Fragillaria—**
" " var amphicephala	

The first species named, Denticula valida, was the most abundant, forming the bulk of the specimen. It may be of interest to note here that this species has been found in the gatherings from the geyser basins of Iceland.

The white pulverulent material at the margin of the bog

proved, upon microscopic examination, to consist of the dried remains of these same diatoms, and it is quite evident that this diatom ooze is forming a bed of diatomaceous earth. Subsequent investigation proves that a diatom ooze, consisting of the same species, forms the chief constituent of similar marshes all over the park.

It has also been found that the meadows of the geyser and hot spring basins were once marshes of this character, and are underlaid by beds of soft straw-colored or gray material which consists of the partially dried remains of diatoms. This material when dried is white, loosely coherent, soils the fingers, and consists either entirely or very largely of diatom tests. A number of specimens of this material collected from the Norris, Lower and Upper Geyser Basins, and the hot spring areas of Pelican Creek, were examined by Dr. Wolle, and found to consist of the species already named, forming a diatomaceous earth that is sometimes very pure, and sometimes mixed with more or less glassy silica formed by the drying of the siliceous jelly with which these organisms so often surround themselves.

These diatom beds cover many square miles in the vicinity of active or extinct hot spring vents of the park, and are often three feet, four feet and sometimes five to six feet thick. The wagon road leading to the geyser basins crosses several meadows of this character, notably immediately south of the Norris basin, Geyser meadows, and the meadows of the Upper and Lower basins of the Firehole. At these places the beds are exposed in the cuttings made for drainage, and square blocks of the dried diatom earth lie scattered about at the sides of the road.

In most of the cases observed, these diatom marshes cover ancient deposits of siliceous sinter, diatoms growing in the cooler waters of the decaying springs or their overflow, and covering the sinter beds until even the tops of the cones are submerged beneath the ooze and the vegetation it supports. This is actually the case at several places in the Lower Firehole Geyser Basin, and at the Lewis Lake and Pelican Creek hot spring areas. Such marshes also occur, however, where the cooler alkaline waters of the geysers and boiling springs overflow the natural surface of the ground.

The diatom ooze thus far observed is from cool or tepid waters, but in the collection of algæ from the hot springs of the park, and placed in the hand of Prof. W. G. Farlow for study and description, specimens of Denticula thermalis (Kg.)

have been found, and Mr. W. P. Blake found diatoms in the hot waters of the so-called "geysers" of California and Nevada hot springs.

U. S. Geological Survey, Washington, D. C.

Flowers and Insects. I.

CHARLES ROBERTSON.[1]

Delphinium tricorne Michx.—The flower agrees in most respects with D. elatum, as described by Müller.[2]

It is blue, but the exposed parts of the two upper petals which arch over the entrance to the spur are white, forming a sure guide to the nectar. In D. Ajacis, according to Sprengel (702),[3] the upper petals also form the pathfinders by a variation in color. In D. elatum yellow hairs on the lateral petals form the guides, while in D. Consolida pathfinders are wanting (Müller).

The lower petal has disappeared, since its attractive function has been usurped by the sepals. It is unnecessary as a protection to the stamens and pistils, and its presence in the median line would only prevent proper contact with the anthers and stigmas.

The parts whose function has been most imperfectly explained are the two lateral petals. These close over the numerous stamens, completely hiding them, but an entrance to the spur is left between them and the upper petals. When a bee visits the flower, the lateral petals are forced aside, and the under side of the bee's head comes in contact with the

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[1] The following series of papers is intended to give the results of observations begun in 1886, near Carlinville, Ill. It has been necessary at first to pay particular attention to collecting and determining the insects. Accordingly, in case of many flowers I am able at present to give only a list of visitors.

Mr. Cresson has compared my bees with his own type specimens in the collection of the American Entomological Society, except species of Halictus and Andrena. Professor S. W. Williston has kindly identified the Diptera. Mr. C A. Hart and Mr. Samuel Henshaw have aided me in identifying the Coleoptera. Prof. G H. French and Mr. Hart have named a number of Lepidoptera for me. I am also under obligations to Prof. S. A. Forbes for access to the collections and literature of the Illinois State Laboratory of Natural History, and to Prof. William Trelease for access to his valuable index of the bibliography and to much of the special literature of fertilization. Prof. Trelease has also placed at my disposal his unpublished notes on the subject and a collection of insects which he has taken on flowers.

[2] Unless otherwise specified, all references to Müller are to Herman Müller: Fertilization of Flowers. See also on this species Delpino: Ulteriori Osservazioni, and Lubbock: British Wild Flowers.

[3] The numbers in parenthesis after an author's name refer to Thompson's bibliography of the literature of fertilization, which is printed with Müller's Fertilization of Flowers. As this book is the most important source of information on the literature, references are practically thrown away on all who do not have access to it.

anthers and stigmas. The use of these petals seems to be to protect the pollen from intruders. Sprengel saw bees collecting pollen of D. Ajacis, and I have seen a very abundant and useful visitor, Synhalonia speciosa, collecting pollen of D. tricorne, but I am convinced that they behave improperly in so doing. Humble-bees, which are best adapted to fertilize the flowers, never gather pollen. On the other hand, I have seen Andrenidæ trying to collect it, and they were only hindered by the lateral petals. But for these petals most of the pollen would be carried away by little bees which would only visit flowers in the male stage.

The spur of the upper sepal is crumpled, and sometimes fits the spurs of the petals so loosely that its tip is empty and hangs down. Indeed, in one case I found the upper sepal entirely empty, and the spurs of the petals stood in front of its lamina. Delpino (178) regards the spur of the sepal as a protection against the jaws of insects which might attempt to cut a way to the nectar, but both he and Riches[4] found some species of Delphinium to be perforated.

As in D. elatum, the spurs of the petals are entire at the tips and open below into a common cavity. The nectar, therefore, is held in two receptacles, and I have observed that when Bombus and Synhalonia insert their proboscides into the spur, they regularly draw back a little and thrust their tongues in again, evidently to extract the nectar from both petals. I think the double nectary is to favor bees, which are intelligent enough to drain both sides, while butterflies will probably leave one side full. This structure might also be of advantage in case of perforation, since the robber would have to make two holes or leave one side full. The double nectary, however, causes delay, and this seems to be the reason why the nectariferous petals of D. Consolida have developed a common cavity throughout.

D. tricorne agrees with the other species which have been studied in being male in the first stage and in being specially adapted to humble-bees.

The spurs of the petals from the point of insertion to the closed part measure from 7 to 9 mm., and to the tips from 15 to 17 mm., so that a proboscis 7 to 9 mm. long is needed to reach the nectar, and one 15 to 17 mm. long to exhaust it. Only the females of Bombus are flying while the plant blooms. B. Pennsylvanicus, with a tongue 16 to 17 mm. long, is best adapted to suck up all of the honey.

[4] Science Gossip, 1877, 249.

Müller found D. Consolida visited by Bombus hortorum and lapidarius. He also found butterflies, Satyrus and Hesperia, stealing honey, and I have found a still greater number on this plant. The presence of these insects on bee-flowers is always important, since it enables us to understand how many flowers which originally must have been adapted to bees have been modified to suit butterflies. The white-flowered form of this plant might easily become adapted to hawk moths.

Müller found D. elatum visited by Bombus hortorum and Anthophora personata.

On six days between May 4 and 13, I caught the following insects on the flowers. Nos. 4 and 6 are characteristic visitors, while 8–18 are intruders:

Hymenoptera—*Apidæ:* (1) *Bombus virginicus* Oliv. ♀; (2) *B. separatus* Cress. ♀ (11–13)[5]; (3) *B. vagans* Sm. ♀; (4) *B. pennsylvanicus* De G. ♀ (16–17); (5) *Anthophora abrupta* Say ♂ (14); all sucking; (6) *Synhalonia speciosa* Cress. ♂ ♀, s. and c. p.; (7) *S. atriventris* Sm. ♂, s.; (8) *Ceratina dulpa* Say ♀ (5–6), crawling into lower part of spur whence it may reach a little nectar. *Andrenidæ:* (9) *Agapostemon radiatus* Say ♀; (10) Halictus sp. ♀, both trying to collect pollen.

Lepidoptera—*Rhopalocera:* (11) *Danais archippus* F.; (12) *Papilio asterias* F.: (13) *P. troilus* L.; (14) *P. turnus* L.; (15) *Colias philodice* Godt.; (16) *Pamphila zabulon* Bd.-Lec.; (17) *Eudamus tityrus* F. *Sphingidæ:* (18) *Deilephila lineata* F.

Nuphar advena Ait.—On the first day the anthers are closed, and are crowded in a compact mass under the edges of the broad stigma. Their fleshy tips keep them from being gnawed by beetles. The petals also protect the lower anthers from gnawing-insects, and secrete nectar on their outer faces. At this time the stigma is receptive, and the flower is therefore proterogynous. The yellow sepals separate so as to leave a triangular opening over the stigma, so narrow that insects can not enter the flower without crawling over the stigmatic surface.

On the second and one or two succeeding days the anthers are dehiscent. The sepals then are often so widely separated that insects are no longer required to come in contact with the stigma.

[5] The numbers after an insect's name indicate the length of the proboscis in millimetres.

In Illinois in August, and in Florida in February, I found the flowers visited by the same species of insects, *Halictus pectoralis* Sm. ♀ (Andrenidæ), and *Helophilus divisus* Loew (Syrphidæ). In Florida I also found it visited by a fly, *Notiphila* sp. (Ephydridæ), and a beetle, *Donacia piscatrix* Lac. (Chrysomelidæ). The beetles were abundant on the older flowers, where they were pairing, the females gnawing the petals and anthers. I tried to catch the visitors by holding my net over the flowers and shaking the stalks, which only made the bees lie more closely, and for awhile I thought visitors were very scarce. Finally, I picked many flowers, and, bending back the sepals, found an Halictus under the petals of most of them, especially the new flowers. All of the bees taken on new flowers were well dusted with pollen from older flowers.

At Madison, Wisconsin, Prof. Trelease (MS. notes) also found it visited by Halictus pectoralis and Donacia piscatrix.

Sprengel (702) found N. luteum visited by beetles of the genus Meligethes. Müller also found it visited by Meligethes, and by Onesia floralis (Muscidæ) and Donacia dentata.

Delpino (178) regards N. luteum as adapted to beetles, but I find no evidence of such adaptation in N. advena; the beetles which occur I regard as worse than useless. However, beetles of the genus Donacia are very fond of the flowers of Nuphar, since they were observed on them by Müller in Germany, by Trelease in Wisconsin, and by me in Florida.

Figures of N. luteum in Hooker's edition of Le Maout and Decaisne's Botany, 208, and in Sprengel, Pl. XXIII, indicate fairly well the male stage of N. advena. I see nothing to lead insects to touch the stigma when the flower is so widely expanded. Indeed, Sprengel says: "Bei der Nymphæa hingegen ist es ein blotzer Zufall, das die Blumenkäfer den Antherenstaub auf das Stigma schleppen," and he regards this as an explanation of the large size of the stigma. Pollination seems so uncertain in such a flower as to incline one to doubt whether it is intended to occur when the flower is so widely expanded.

Nymphæa tuberosa Paine.—In Southern Illinois this plant blooms from May until October. The flowers open in the morning sun and close in the afternoon.

On the first day the flowers are not widely expanded, looking like buds at a distance, and the first stage is likely to be overlooked. The petals stand close together, leaving but

a narrow entrance. The stamens stand in a compact circle close to the petals, and the anthers are indehiscent. The filaments vary from the outer, which are long and broad, to the innermost, which are short and slender. The claw-like scales which surround the concave stigma form with it a little bowl, which holds a large drop of water. At this time the stigmatic papillæ are well developed, and the flower is evidently in the female stage.

On the second morning the water has disappeared from the stigmatic basin, and the papillæ look dry and shrivelled. The claw-like scales are curled in strongly over the stigma, and the inner stamens, which are now dehiscent, have fallen over it, so as completely to hide it. The outer stamens are turned outward, and the petals are widely expanded.

Of eight flowers which were marked, four opened on three days and four on four days. One of the latter had some anthers still closed at noon of the fourth day, promising to open again on the fifth. The flowers are therefore female on the first day and male for two or three days after. It follows that, when about the same number of new flowers open daily, there will be two or three times as many in the male as in the female stage.

All of the insects which I saw on the flowers were in search of pollen, which the numerous stamens yield in abundance. Insects coming from the old flowers drop into the new ones, and plunge into the stigmatic basin. If, in their attempts to escape, they trust their weight to the inner stamens, these bend so suddenly as to throw them again into the water. If the insect does not drop into the stigmatic basin, but lights on the stamens, the slender filaments act like the lip of Calopogon and let him down upon the stigma.

The water on the stigma seems to be intended to loosen the pollen from the scopæ of bees which have been collecting it on the older flowers. I have not discovered any sweet taste in the water, nor have I seen insects attracted by it. Moreover, it seems to be present in too great quantity for the purpose of nectar. Indeed, when insects are thrown back repeatedly into it, they may be drowned. I have seen Agapostemon radiatus and Halictus occcidentalis drowned in the same basin.[6]

If my interpretation is correct, the flower is remarkable

[6] A. Bacon (Torr. Bull. V, 51) found dead insects in flowers of N. odorata, which he supposes were captured by the flower closing up. Delpino (178) also found dead insects in N. alba, and considers their death as a result of the heavy odor of the flower. Planchon (Flore des serres et des jardins, 1850) thinks it a result of the accumulation of carbonic acid in the bottom of the flower

for having perfected a proterogynous condition, although visited exclusively for pollen. Even when nectar is present, many insects in search of pollen only visit dichogamous flowers in the male stage. We have observed that most of the flowers are discharging pollen, so that insects drop carelessly into them and are evidently surprised when they find themselves in the stigmatic basin of a new flower. Attracted by the abundant stamens, they do not discover their mistake before they touch the stigma. However, I have sometimes seen Halictus pectoralis turn away from a new flower into which it was about to drop, and fly to an old one.

On ten days between May 22 and September 18, I took the following insects on the flowers: Hymenoptera—*Andrenidæ:* (1) Agapostemon radiatus Say ♀, c. p., ab., sometimes drowned; (2) A. nigricornis F. ♀, c. p., ab.; (3–4) Halictus spp., ♀, c. p.; (5) H. pectoralis Sm. ♀, c. p., ab.: (6) H. occidentalis Cress. ♀, c. p., sometimes downed; (7) H. coriaceus Sm. ♀, c. p. do.; (8) Prosopis sp. ♀, e. p.

Diptera—*Syrphidæ:* (9) Helophilus divisus Lw. e. p., ab.; (10) H. latifrons Lw., e. p. *Bombylidæ:* (11) Sparnopolius fulvus Wied.

Coleoptera—*Rhipiphoridæ:* (12) Rhipiphorus limbatus F., drowned.

Nymphæa odorata L.—The flower resembles N. tuberosa, and is likewise female in the first stage. In Florida, in February, I have seen it visited by Halictus pectoralis Sm. ♀.

Delpino (178) regards Nymphæa as specially adapted to beetles. He states that Piccioli found N. alba abundantly visited by Donacia.

Dicentra Cucullaria DC.—The flower is figured and its mechanism described by Hildebrand (358). A peculiar interest surrounds it from the fact that its time of blooming is correlated with the appearance of long-tongued bees, and in my neighborhood it is the first flower adapted to them. In April, 1886, the first open flower was observed on the 7th, with no visitor. April 9, I found hive-bees collecting pollen and Papilio ajax sucking. April 11, hive-bees were collecting pollen, Bombylius, butterflies and the first humble-bees were sucking. On the 12th, humble-bees were present in considerable numbers for the first time, so that it required six days for the proper insect relations to become established.

The two inner petals are united over the anthers, protect-

ing them from insects which are in search of pollen, so that the flowers are only adapted to be visited for honey. But the hive-bee visits the flower only for pollen, and I have seen no better illustration of its ingenuity than its success in gathering it. With its head it pushes aside the inner petals, partly separating them, while it removes the pollen with its front feet.

The pendulous position of the flowers makes them inconvenient for all visitors except bees (and Bombylius), but butterflies sometimes hang under the flowers and steal some of the nectar.

The nectar is secreted by two long processes of the middle stamens, and rises to the tip of the spur. A proboscis about 8 mm. long is necessary to reach it, and one 12½ to 14 mm. to obtain all of it. The females, which have longer tongues than the males and workers, are the only individuals of Bombus which fly while this plant is in bloom, and since the shortest-tongued of them can easily reach the nectar, it is strange that any should ever be guilty of cutting holes in the flowers. I have seen many individuals of four species sucking, but never perforating. However, the flowers are sometimes perforated by humble-bees (?), according to Leggett, Bailey, Stone and Merriam[7]. One observer states that humble-bees made the holes, and that honey-bees were sucking. The honey-bee's tongue is only 6 mm. long, and can hardly reach any of the nectar, and although I have seen this bee collecting pollen very often, I have never seen it sucking. His honey-bee was evidently a Synhalonia.

Observed on ten days, between April 9 and 30. Nos. 2–12 are proper visitors, the rest intruders. Hymenoptera–*Apidæ:* (1) Apis mellifica L. ☿, c. p.; (2) Bombus virginicus Oliv. ♀; (3) B. separatus Cress. ♀; (4) B. vagans Sm. ♀; (5) B. pennsylvanicus DeG. ♀; (6) Anthophora ursina Cress. ♂; (7) Habropoda floridana Sm. ♂; (8) Synhalonia atriventris Sm. ♂; (9) S. honesta Cress. ♂ ♀; (10) Osmia latitarsis Cress. ♂; (11) O. montana Cress. ♂; (12) O. lignaria Say ♂ ♀.

Diptera–*Bombylidæ:* (13) Bombylius fratellus Wied., sometimes on cold days the exclusive visitor.

Lepidotera–*Rhopalocera:* (14) Danais archippus F.; (15) Pyrameis atalanta L.; (16) Papilio ajax L.; (17) Pieris rapae L.; (18) Nisoniades martialis Scud., all sucking, except 1.

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[7] See Pammel: Trans. St. Louis Acad. Sci., v. p. 274.

Notes on the flora of Iowa.

A. S. HITCHCOCK.

Iowa can not boast of a flora remarkable for its diversity. It contains no mountain ranges, no arid deserts, no sea coast, extended lake shore or dreary swamp. It is essentially a prairie state, but is not included in that vast and characteristic region known as the "Great Plains." It lies on the western border of what is known as the "Manual region." Of the phænogamous plants recorded for Iowa (about 1,300 species and varieties), there are not more than forty that can not be found in Gray's Manual. Part of these have been described since the manual was written, and are found within the geographical limits covered by this most excellent book. Nearly all the remainder are to be found only in the extreme western part of the state.

Although there are no dense forests in the state, yet the wooded flora is quite diverse. With the exception of conifers, Iowa will compare favorably in this respect with other states having more varied geological characters.

Of the order Coniferæ five species are recorded by Prof. Arthur. I have seen but two, viz., *Juniperus Virginiana* L., in the northern part of the state, and *J. communis* L., which is quite common along the Iowa and Cedar rivers.

The number of species of trees, as well as individuals, increases as one goes south or east from the northwest corner of the state. The oaks increase from three to thirteen. *Populus monilifera* Ait. is replaced by *P. grandidentata* Mx. and *P. tremuloides* Mx. In the southern part are found *Quercus imbricaria* Mx., *Cercis Canadensis* L., and *Asimina triloba* Duval, which are more southern in their range; in the eastern part *Dirca palustris* L. and two species of birch, which are eastern.

The only portion of the state that shows any radical difference from the rest, as regards its flora, is the western border, the bluffs along the Missouri river.

From Hamburg, in the southwestern part of Iowa, to Sioux City, where the river leaves the Iowa line, we find the bluffs extending like a miniature range of mountains, as seen from the river, sometimes with the muddy Missouri flowing at their base, and again several miles away.

At Hamburg they are five miles back, but rise precipi-

tously to a height of 100 or 200 feet, so steep, in many places, that one could not ascend were it not for the terraces. In most places the side of the bluff is devoid of trees, although often wooded at the summit and further back.

The flora of the plains has crossed the river and obtained a firm foothold upon this narrow strip of land, not more than a few hundred feet in width. Many of the plants so plentiful on the bluffs are not found further east, except as strays.

As examples of this flora I will mention *Houstonia angustifolia* Mx., *Yucca angustifolia* Pursh., *Gaura coccinea* Nutt., *Dalea laxiflora* Pursh., *Oxytropis Lamberti* Pursh., and *Astagalus lotiflorus* Hook., var. *brachypus* Gr. The last named species has not before been recorded for the state. It was kindly determined for me by Dr. Sereno Watson.

Two aquatic plants of a more southern range, and both new to Iowa, were found in this most interesting region, *Heteranthera limosa* Vahl. and *Echinodorus rostratus* Eng.

At Sioux City we find a more typical prairie region. Trees are scarce, except on the low land near the river. The flora here is quite as interesting as at Hamburg, and several "finds" were made.

Early one morning I started out to conquer the Sioux City flora. Being in a conquering mood my first duty was to climb to the top of a steep and arid bluff which looked as if it might bear some hidden treasure to reward the first comer who should dare to scale its lofty heights, and indeed I was rewarded for my labor by finding two plants new to the state, *Linum rigidum* Pursh. of the plains, and *Stipa comata* Trin. of the Rocky Mt. region. I have Dr. Vasey to thank for the latter name. *Aplopappus spinulosus* DC., *Grindelia squarrosa* Duval, and *Liatris punctata* Hook., were also found here.

Having espied a promising sandbar in the distance I descended to the river. I had not tramped over the sand very far before I noticed, here and there, some trees with shining leaves. Thinking they were willows I prudently passed by on the other side. But finally I was brought face to face with one of the little trees and found it covered with small red berries. My willow was *Shepherdia argentea* Nutt. Not supposing it to be thorny I began boldly to capture specimens. I was quickly brought to grief, however, for although it has no true thorns, yet its sharp and stunted branchlets act just as defensively. This species has not been reported before, and undoubtedly wandered down the river from the northwest, where it abounds.

Another interesting plant here was a very woolly thistle, which was a puzzler. I sent it to Dr. Watson, who says it is *Cnicus altissimus* Willd., var. *filipendulus* Gr., remarking that it was near *C. undulatus* Gr. The range given for this in the Synoptical Flora is Texas to Colorado. According to that it had strayed a considerable distance from its home.

Another plant was found the same forenoon, which is worth mentioning, namely Salsola Kali. It was very abundant, but apparently introduced, probably from the northwest, where, I believe, it is found.

As the Spirit Lake region is pretty well known to any who would be interested in Iowa flora, I will not describe it.

At the south end of Lake Okoboji the beach runs directly to the prairie. Walking back a few rods, I came to a patch of grass which I decided was *Agropyrum violaceum* Lange. But Dr. Vasey, on seeing the specimens, decided differently. He said it was *A. unilaterale* V. & S. A. violaceum had been admitted to the Iowa flora on some specimens contributed by Mr. R. I. Cratty, of Armstrong, Emmet county. I wrote to Mr. Cratty, who has contributed largely to the Iowa flora, and he very kindly sent me a specimen of his A. violaceum, which seems to be identical with A. unilaterale, in which case the former must be expunged from the list of Iowa plants and the latter added.

In speaking of reported Iowa plants, I refer to Prof. J. C. Arthur's "Contributions to the Flora of Iowa."

Iowa City, Iowa.

BRIEFER ARTICLES.

Nonnea rosea.--Escaped from my garden, this has become rather abundant as a weed in the vicinity, and promises to be one of our earliest spring flowers. We have not had severe weather, but the thermometer has been so regularly below freezing point, that only yesterday (March 17), it was high enough to start chickweed and Draba verna into bloom. The Nonnea is also keeping company. Honey-bees are trying to glean something from all three, though, later in the season they neglect them for better fare.—THOMAS MEEHAN, *Germantown, Pennsylvania.*

Dicentra stigmas and stamens.—When a half-developed flower-bud is examined the six stamens are seen to have their anthers upon a level with the capitate stigma. Soon after this, and before the petal-tips turn down, the anthers have dehisced and the pollen is in contact with the irregular and roughened surface of the swollen tip of the style. This tip is flat, and suggests the part of a watch key which is grasped by thumb and

finger in turning. Around this irregular and lenticular body the stamens are arranged with one at each narrow edge and two midway upon each side. The two stamens at the edges have each two lobes, while the other four are half stamens. Each pair of half stamens has the two anthers, that is, half anthers, so placed together as to seem like a single stamen. However, each has its filament, which starts from a higher point upon the receptacle than the full-sized stamen and then arches considerably below it. This is particularly evident in Dicentra spectabilis. When the petals are removed the stamens and pistil together have somewhat the appearance of a Jew's-harp. Each bow consists of a single whole stamen filament and the filament of a half stamen upon each side.

Transverse sections through the capitate stigma reveals the fact that there are, in addition to the large protuberances upon the edge of the stigma, a number of small ones over the sides of these protuberances. As the transverse sections show, these small projections extend into the cavities of the dehisced anthers, and as the flower matures the stamens draw down, due to the peculiar arched shape of the filaments or from the prolongation of the style, or both. As a result, the rough surface of the stigma becomes the portion bearing the pollen at the time when the flower is ready for the visitation of insects.—BYRON D. HALSTED, *Rutgers College, New Brunswick, N. J.*

Erysimum cheiranthoides.--This crucifer, not listed in the Michigan catalogue of Wheeler and Smith, I found June 28, 1888, quite abundant on low, muddy ground, near the Au Sable river, Grayling. Although not far from a road, it appeared to be indigenous.

Prof. L. H. Bailey found it growing near Lansing about ten years ago.

C. K. Dodge found it near Port Huron last season, also.

These are the only known localities in the state.—G. H. HICKS, *Owosso, Mich.*

EDITORIAL.

AMERICANS are progressive. They do not fail to remind themselves of the fact often, and in the reiteration quite lose sight of the progress made by the rest of the world in lines little or not at all developed in this country. Why we have almost no botanical gardens, while in Europe all large institutions for higher education and many large cities consider them essential to full prosperity, is worth considering. It is not solely because we are a young nation, for Australia has gardens established in the early days of the colonies which, under the fostering care of municipal governments, have become spots of rare loveliness, and according to the estimate of the people are as useful and profitable as they are attract-

ive. The most notable of the few gardens in our own country is that at Cambridge, and it would be a pertinent inquiry as to what share of credit the garden is entitled in the ascendency of Harvard University, especially as a school of science. But the Cambridge garden has never attempted to advance economic interests or to furnish diversion for visitors; its finances have not permitted such expansion. For some time past the subject of a botanic garden for New York city has been agitated, and with encouraging results. Several of the New York dailies, with medical, gardening and other journals, have advocated it. The movement is, as it should be, under the direction of the Torrey Botanical Club. Besides creating a strong public opinion in its favor, the club has secured the passage of a resolution by the commissioners of public parks for setting aside a suitable piece of ground in one of the new parks, provided a proper endowment fund be obtained within two years. The club considers one million dollars the minimum amount required. To those who know something of the cost of foreign gardens of this sort, the sum will seem small enough. The new garden at Strassburg cost $225,000, and it comes far from being adequate to the needs of a great city like New York. The success of this movement means not only a valuable acquisition for the city and the people who have the opportunity of visiting it, but a great boon to American botanical science. The Torrey Club is entitled to all the support in this great undertaking her fellow botanists can render.

CURRENT LITERATURE.

Peach Yellows.

The large handbooks of plant diseases by the German authors, Frank and Sorauer, present a remarkable array of maladies in the vegetable kingdom, far exceeding the number most persons would suppose possible. But, of the numerous diseases so far recognized, only a very small part has received adequate study, and the number for which acceptable remedies or preventives can be confidently prescribed is astonishingly small. The German works referred to are the only comprehensive treatises of the kind yet published, and still they do not include some of the most prominent and destructive diseases which trouble the American cultivator.

The increasing attention given to the subject in this country, by the cultivator on the one hand, in recognizing the value of the work already done, and by the investigator on the other hand, in more thorough study, particularly of the distinctively American maladies, present a hopeful outlook for this branch of applied science.

Of the strictly American plant diseases probably none has had more prominence, proved so unmanageable and has so effectively baffled all at-

tempts to determine its cause and obtain suitable remedies or even to accurately diagnose, as that of peach yellows. The unusual difficulties which the study of this disease presents, lend much interest to all well directed efforts toward elucidating the subject. The most important paper in this line yet published is that of Mr. Erwin F. Smith,[1] recently issued as Bulletin No. 9 of the Section of Vegetable Pathology of the Department of Agriculture. The practical fruit-grower will doubtless feel disappointed when he looks through this rather thick report, as he will be unable to find answers to the two great questions: "What is the cause?" and "What is the remedy?" But if Mr. Smith has not found the key that unlocks the entrance to the field, he has certainly defined the limits of the field, given a large amount of information regarding the lay of the land, and carefully traced its history, in short has made a comprehensive and lucid statement of the whole subject as it stands at the present time, backed up by a long array of authority.

The report covers the work of sixteen months, far too short a time to institute and conclude much experimental evidence. The results of this part of the inquiry will doubtless appear in a later report. But besides properly assorting the incongruous views of others, Mr. Smith has added valuable knowledge from his own observations, particularly regarding the diagnosis of the disease and its distribution.

There is record of peach yellows occurring near Philadelphia as early as 1791, and it is known that peaches had been in cultivation in this country for more than one hundred and fifty years prior to that time. At first the disease was local, but rapidly became general in the northern Atlantic states and spread westward and northwestward. At present it is scarcely known in the Gulf states or west of the Mississippi, and not at all on the Pacific coast. The author gives an idea of the large amount of capital invested in the peach industry, and the heavy losses which have resulted in many districts from the yellows. The disease is found to be contagious, at least it can be communicated to healthy trees by budding from diseased trees. The author speaks very cautiously respecting the cause, suggesting micro-organisms as highly probable, although he considers that root-aphides and root-fungi have some claims. Much attention is given to the theory of soil exhaustion, so ably advocated by Dr. Goessmann and Prof. Penhallow, but the author finds it faulty and inconlusive.

The illustrations of the report are well selected and well executed, especially the colored ones.

Altogether, both the author and the public are to be congratulated upon the excellence and completeness of this presentation of an economically important and difficult subject. The questions of cause and remedy are yet to be answered, but with the evidence of good work before us,

[1] SMITH, ERWIN F.—Peach Yellows: a preliminary report. 8vo., 212 pp, 9 colored maps, 37 partly colored plates. Washington 1888.

there can be no doubt that if suitable facilities are afforded, the author will make, in due time, an equally valuable contribution to this phase of the subject.

Minor Notices.

IT IS a great gain to botanical science when botanico-chemical questions are treated by an investigator trained in both botanical and chemical methods. Such foundation for work has enabled Dr. W. E. Stone, now of the experiment station of Tennessee, to carry out an interesting and important study of arabinose.[2] This substance is found in gum arabic, but that used was from the gum that exudes from cherry trees. It was found, contrary to the views of other investigators, to belong to a series distinct from that of the true sugars, and unlike them to give a reaction for furfurol when heated with sulphuric acid. The work involved the employment of a method for the pure culture of yeast, and a study of the conditions of a successful fermentation, already referred to in this journal.

AN INTERESTING PAPER on the paleontological history of the genus Platanus, by Prof. L. F. Ward, has recently been distributed as an excerpt from the Proceedings of the U. S. National Museum.[3] It shows that this small genus of only seven existing species was at its zenith in the Cretaceous and Tertiary periods. A prominent characteristic of the archaic forms is the basal lobes of the leaves, now only occasionally met with on young shoots. By means of these lobes and the venation of the leaves the genetic relationship is pointed out between several fossil forms referred to different genera and their living representatives.

M. P. MAURY has prepared an enumeration[4] of the Cyperaceæ collected in Ecuador and New Grenada by André. Previous reports upon other orders have called attention to the richness of the collection of M. André. The present list comprises 58 species, of which two of Cyperus, one of Dichromena, and one of Rhynchospora are new. The paucity of Carices is quite remarkable. The reprint is re-paged, a most reprehensible practice, as it seems to us, and one for which there is not the slightest excuse.

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[2] STONE, WINTHROP E.—Investigations concerning arabinose and some related substances. 26 pp., 8vo. Knoxville, 1889.

[3] L. c., 1888, p. 39, plates xvii–xxii; also abstract in Proc. Am. Assoc. Adv. Sci., vol. xxxvii, p. 201.

[4] MAURY, P.—Les Cypéracées de l'Ecuador et de la Nouvelle-Grenade de la collection de M. Ed. André. Reprint from *Journal de Botanique* for Nov. 16 and Dec. 1, 1888. Imp. 8vo., pp. 14. Paris: J. Mersch. 1889.

· OPEN LETTERS.

The Origin of Floral Structures.

I am always glad to receive criticisms of my theory from an opponent, but my reviewer, "R.," somewhat misrepresents me rather than criticizes, for he says (BOT. GAZ. xiii, 324): "The Darwinian theories of natural selection and of cross-fertilization are thus wholly repudiated." My exact words are (*Or. of Fl. Str.* p. 336), "I do not wish the reader to suppose that my theory is altogether in opposition to Mr. Darwin's." I by no means reject natural selection, and even give the result of an experiment showing how a hard Russian wheat when sown thickly with a soft English grain was "selected," as that only carried ears. I adopted the expression "constitutional selection" as best describing that kind. I recognize natural selection as a factor in several ways, but never as *a cause*, and so not having the importance which has generally been attached to it. None of my many reviewers have credited me with denying it, either in England or America, except "R." "R." quotes the Papilionaceæ as opposed to my theory, in having the standard larger than the anterior petals; but this agrees with well nigh all irregular flowers in which the stamens afford the landing place, *e. g.*, Pelargonium (except "the Scarlets"), Rhododendrons, horse-chestnut, Amaryllis, etc. I have attributed this result in part to atrophy of the anterior petals (p. 111) without precluding a certain amount of hypertrophy on the opposite (dorsal or posterior) side (p. 116). "R." must have overlooked what I have written on this as well as on the resupinate labellum of Orchis (p. 107). "R." assumes Verbascum to be a further advance of the Personales. I regard it as an ancestral form and as more nearly approaching the primitive and regular type of flower; for I know of no case where an irregular flower passes into a regular one *except in a pelorian condition* (see chap. xiv). This Verbascum most certainly is not. Why "R." calls zygomorphic types "ancient" does not appear. This is one difference of importance between our respective views, in that I ventured to offer my theory as suggestive or as a "working hypothesis" only (p. 3); on the other hand, "R." states his opinions in a very categorical manner, as if they were not open to doubt at all. Thus he says: "Although it is evident that natural selection must act"—why "evident"? why "must"? I agree with Prof. Huxley, who says that a scientist does not know the word "must." If "R." had pointed out *how* natural selection produces a combination of minute characters in all the organs of a flower, including the floral receptacle; and *all* in harmonious correlation with insect fertilization; I should have been glad to have read it (see p. 330) and his review would have been more satisfactory; but merely to say natural selection "must" have brought them about is neither an answer nor a criticism.

I can only add that I am extremely gratified to find that the views of such able naturalists as Prof. Packard, A. W. Hyatt and others to be thoroughly in accordance with my own. I had no conception that neo-Lamarckism was so widely sustained in the United States.

London, England. GEORGE HENSLOW.

I am satisfied to leave the reader with the context of Prof. Henslow's quotation: "Instead, therefore, of using this term (natural selection) as the cause of anything and everything, I prefer to attribute effects to hypertrophy, atrophy, resistance to strains, responsive action to irrita-

tions, and so on. If it be thought that natural selection somehow underlies all this, the reader is at liberty to substitute the phrase; but, I must confess, it conveys nothing definite to my mind, while the others undoubtedly do. I do not wish the reader to suppose that my theory is altogether (sic) in opposition to Mr. Darwin's; for it must not be forgotten that he himself laid great stress on the environment as a cause of variability upon which, when once brought about, natural selection could then act." I understand this to mean that he agrees with Mr. Darwin in ascribing effects to environment, but not in regard to natural selection. The fact that H. denies the advantage of cross-fertilization is sufficient ground for saying that he repudiates natural selection as an explanation of floral mechanisms. I regard natural selection, not as a cause of hypertrophies and atrophies, but as a cause of adaptations, the most important characteristics of organs and organisms. However, I think of natural selection not so much as a cause as a controller of causes. No doubt H. regards heredity as a cause. But heredity can only insure that a given generation shall resemble its progenitors. Natural selection determines who those progenitors shall be. In regard to other reviewers I quote from *Journ. Bot.* xxvi, 313: "Professor Henslow, for example, is a well-known upholder of the principle of evolution; but in the present work he vehemently combats two of the theories which are most closely associated with the great name of Darwin." H. regards a flower as a geologist would regard a hill, *i. e.*, as a resultant of all the forces which have been brought to bear upon it. But organisms resist or avoid the direct effects of their environment, being active in controlling their conditions, or in adjusting themselves to them. In opposition to this view, I hold that many highly specialized flowers, instead of developing to suit their principal visitors, have contracted the parts in front of the receptacle, excluding one set of visitors after another from the landing until the largest bees could only insert their tongues, *e. g.*, Trifolium pratense and Amphicarpæa monoica.

However, from the standpoint of pure Lamarckism, if we admit that insect contact has a given effect, I hold that the theory will not account for the facts of floral structure. If insects leave the perianth altogether, H. claims that the whole perianth atrophies. If they leave the perianth and light upon the stamens, the perianth atrophies below and hypertrophies above. In the case of Papilionaceæ, etc., I claim that at first direct insect contact was equally absent both above and below and had nothing to do with the reduction of one part or with the enlargement of the other. What he calls atrophy-hypertrophy are the things to be explained, and they can not furnish the explanation. The labellum of orchids is also against the theory. My view is that it was developed as a vexillum on the upper side of the flower, and that its enlargement instead of being a result of its use as a landing after inversion is rather the cause of the inversion. Moreover, in my neighborhood, Habenaria leucophæa, visited by hawk-moths, which suck without touching the labellum, has this part as well developed as in Orchis spectabilis, whose labellum forms a landing for humble-bees. What does insect contact have to do with the colored bracts of Euphorbia and Cornus florida, or with the neutral flowers of Hydrangea and Helianthus annuus?

I consider Verbascum a degradation rather than an advance of the Personales. I call the zygomorphic type of Personales ancient, because it is the type of the cohort. Campanula Americana is in the first stage of zygomorphy. The type of the genus Campanula is actinomorphic. But in the case of Verbascum the type not only of the great order of

Scrophulariaceæ, but also of the great cohort of Personales is zygomorphic. In the Campanula the irregularity is limited to the deflection of the style, while in Verbascum it involves both the stamens and petals. I suppose the type of Scrophulariaceæ to have been a flower with a tube long enough to cover the stamens so that insects could not light upon them, and so narrow as to crowd the stamens and style when they changed to the upper wall. The common form is both nototribe and didynamous, but I do not believe that a flower like Verbascum, with rotate corolla and exposed stamens, could develop either of these characters. Delpino regards Mentha as a degraded form of the Labiate type, and I am inclined to think that he is right.

Finally, for a discussion of zygomorphy from the standpoint of natural selection, and for a refutation of Henslow's view that floral organs must have varied simultaneously, see BOT. GAZ. xiii, 146, 203, 224.

R.

Some queer botany.

One runs across some funny botany in doctor books designed for home use! A few days ago I picked up a *vade mecum* of this sort written by an "M. D." who further styles himself "Licentiate of the Royal College of Physicians, Member of the Royal College of Surgeons (London)," with a lot more of high-sounding degrees. Here is what amused me. "*Podophyllum peltatum.* This plant, of the genus *Mandragora* [nothing like being scientific] has been supposed to be the same as that of which we read in the Scriptures as the mandrake. Its fruit, which is round and yellow, like a small orange, is very fragrant and luscious [mawkish, eaten by pigs and boys, *fide* A. Gr.] and is eaten in the East [wonder if that means "down east"] by women desirous of perfect health. The tuberous (?) root is the officinal portion." And this balderdash in a "sixth edition, thirty-third thousand"!

M. S. B.

Persian lilac on Weigela.

Last summer John Thorburn, LL. D., while visiting Yarmouth, Nova Scotia, discovered close to a house a bush of Japanese Weigela rosea on which there was a branch of Persian lilac carrying fine trusses of flowers. The specimens taken are now in our herbarium, and are undoubtedly as mentioned above. The lilac bushes grew at the back of the house and none where the Weigela grew. As Dr. Thorburn is one of our officers and a reliable gentlemen, I mention the circumstance as being noteworthy and solely on his authority.

JOHN MACOUN.

Ottawa, Canada.

Numbers of the Gazette Wanted.

The series of numbers making a nearly complete set of the BOTANICAL GAZETTE, which the editors have generously presented to the Marine Biological Laboratory at Wood's Holl, Mass., is such a valuable acquisition to our library, and is to benefit such a large number of persons that we are very desirous to fill out the set. Are there not among your readers some who can furnish to the laboratory as gifts or for purchase the lacking numbers? We require still: Vol. III, No. 10; Vol. VI, No. 9; Vol. VII, Nos. 8, 9, 11; Vol. VIII, No. 5; Vol. IX, Nos. 10, 11; Vol. X, Nos. 7, 8, 11, 12; Vol. XI, No. 1.

Boston. CHARLES S. MINOT.

NOTES AND NEWS.

DR. OSCAR UHLWORM has retired from the editorial supervision of the Bibliotheca Botanica. His place is to be taken by Dr. Luerssen of Königsberg.

PROF. W. W. BAILEY reports Houstonia cærulea in bloom at Providence, R. I., on March 26th, "my earliest date in twenty-six years." "Forsythia pendula bloomed here out of doors all winter."

F. A. F. C. WENT, whose interesting studies on vacuoles have been noted (see this journal, xiii. 280) has extended his observation on their origin. Most of his previous studies have related to vegetative cells. He has now investigated the reproductive cells of a large number of algae of various widely separated groups. He finds his previous conclusions confirmed. Vacuoles arise exclusively by the division of previously existing ones.

SINCE the notice of his investigations on the origin of the antherozoids of the Characeæ (ante, p. 87) M. Leon Guignard has extended his studies to the antherozoids of the Hepaticæ, Musci, Filices and Fucaceæ. In recent numbers of Comptes Rendus (cviii, 463, 577) he has summarized his results. In the Fucaceæ each antherozoid is simply an ordinary naked, pyriform cell. It is furnished with a nucleus, situated near the "red spot," and with two cilia of unequal length. The body is very large and contains all the protoplasm of the cell. The cilia arise from a ring of protoplasm on the surface of the body which differentiates itself from the rest by becoming hyaline. The nucleus of the antheridium divides by the usual steps into sixty-four daughter nuclei, so that sixty-four antherozoids arise from each antheridium. At the same time the colorless chromatophores multiply to a much greater number. Each nucleus then joins itself to one of the colorless chromatophores. The remainder quickly become yellow or orange. By the time the formation of the antherozoids is complete, however, these have lost their color and been absorbed, while the chromatophore accompanying the nucleus has become the "red spot." In the other plants named above, in all cases the nucleus, and the nucleus alone, forms the body of the antherozoid. The nucleus moves to one side of the mother cell and begins to elongate, the slender anterior end remaining stationary. This elongation continues till two or more spiral coils have been formed. Then a portion of the protoplasm just outside of the nucleus differentiates in the same manner as described above for the formation of cilia. This differentiated portion may be only a band (when the cilia are to be few, as in the Hepaticæ and Musci), or the whole layer, when the cilia are numerous, as in the ferns. The remaining protoplasm is either completely (Hepaticæ) or partially absorbed (Filices). In the latter case a vesicle is formed which encloses minute starch grains and the residue of the protoplasm. The transformation of the nucleus is accompanied by internal modifications which render the spiral body almost homogeneous. It is covered with an extremely delicate hyaline envelope.

DR. SELMAR SCHÖNLAND, of Oxford, has been called to the curatorship of the Albany Museum in Grahamstown, S. Africa.

DR. E. ZACHARIAS has published in the last number of Pringsheim's Jahrbücher (xx, heft 2) some observations on the origin and growth of the cell wall of the rhizoids of Chara, which are very much in the same line as

the recently published investigations of Kohl[1] on the hairs of Borraginaceæ, Urticaceæ, Cucurbitaceæ, etc., and earlier ones of Krabbe[2] on bast fibers. The earliest appearance either in the case of a new wall or a thickening layer, is a great number of swarming particles which quickly change into a rodlet structure. This consists of a series of very short rods set side by side, with minute prolongations of the protoplasm between. These rods grow larger and larger and become the solid wall or new layer. All attempts to demonstrate the chemical nature or origin of the first-appearing particles failed. The rodlets give the cellulose reaction. These observations taken in connection with those referred to above make it tolerably certain that there is a form of growth in thickness of the cell wall that is neither apposition nor intussusception, but which consists in the addition bodily of a new structure. And it is quite possible when a new layer is put on in this way that some proteid materials should be included between the older and newer layer. This mode of growth in thickness is quite in contrast with the views heretofore held by Strasburger and others. Strasburger's latest contribution to this subject is just issued and has not yet come under our notice.

Woronin has recently described a disease of cranberry plants produced by the attack of a new species of Sclerotinia, *S. Vaccinii* Wor. The fungus attacks young shoots in spring and makes them yellowish-brown to black, the discoloration gradually extending to the leaves. The conidia are formed in a thick pseudo-parenchymatous swelling which involves the cortex. They are formed by constriction without any transverse wall until after the apical growth of the conidiophore has ceased. Then they are pushed off by a curious device, and carried by the wind or insects to the stigmas of flowers. Here they grow as pollen grains would and fill the cavity of the ovary with hyphæ. From the outer ones branches invade the ovary wall and convert it into a sclerotium. This drops oft, withers among the leaves and moss, and as the snow melts in the spring forms fruiting branches. The ascospores are ejected in the same way as in Claviceps and the young shoots are infected toward the end of May. The germ tube penetrates the epidermis wall and reaches the fibro-vascular bundle where it develops as before.

In the February number of the *Journal of the Royal Microscopical Society* Mr. William West gives a list of Desmids collected by Prof. Tyler, near Amherst, Mass. The list comprises eighty-four species and five varieties or forms. Of these two are new species and four new varieties. The paper is illustrated by two plates.

A work on British Uredineæ and Ustilagineæ, by Charles B. Plowright, has been published, and will receive suitable notice in our next number. It is issued at $2.65 (10*s.* 6*d.*), and, after the conservative English method, subscribers (who pay only 8*s.* 6*d.*) are required to forward the price before receiving their copy.

Muscarine, heretofore considered as belonging exclusively to certain poisonous mushrooms, has been detected in a Japanese food, consisting of rice and fish, as a product of decomposition. A case of food poisoning, in which four persons lost their lives, was investigated by Dr. H. E. Stockbridge (Report of the chemist to the Hokkaido Cho, 1888) and the active agent found to be a ptomaine with the properties of muscarine.

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[1] Bot. Centralblatt xxxvii. 1.

[2] Prings. Jahrb. xviii. 346.

VOL. XIV. NO. 6.—BOTANICAL GAZETTE.—JUNE, 1889.

Sub-epidermal rusts.

H. L. BOLLEY.

(WITH PLATE XV.)

During the past year I have made a structural study of the teleutosporic stage of *Puccinia coronata* Cda. and *P. rubigo-vera* DC. upon different hosts with the hope that careful work would reveal, among other things, some differentiating structural characteristics. To be of worth, such defining marks must be constant through all variations of an individual species. Though the work was not wanting in interest, it may be well to say that, with regard to the discovery of such diagnostic features, my observations have been essentially negative; for structural variations which upon some hosts were often quite marked were upon others either absent or so slight as to be of no comparative value.

In most species of Uredineæ, the teleutospores break through the epidermis of the nourishing plant (fig. 1), but in both the species mentioned they reach maturity in the matrix or sorus without rupturing the enclosing epidermis (fig. 2), a condition which is typical of a number of other species, which, for convenience in this paper, have been termed "sub-epidermal."[1]

These species, because of their similarity of development, present many common peculiarities of form and structure. In some cases, as P. coronata and P. rubigo-vera, species grade the one into the other so closely as to nearly defy separation upon a structural basis. Upon examining type spores of these two forms, one immediately notices the striking differences in the apices, P. coronata being possessed of a crown of flame-yellow finger-form projections, while those of P. rubigo-vera are truncate (fig. 13 and 12, *a* and *b*). These, however, are not constant characteristics. Some specimens of P. rubigo-vera produce teleutospores which show a strong tendency to form points, and many specimens of P. coro-

[1] P. scirpi DC. †; P. eleocharidis Arth. †; P. striatula Peck †; P. vulpina Schroet. †; P. anemones-virginianæ Schw. †; P. galiorum Lk.; P. sessilis Schneider; P. obscura Schroet. †; P. phalaridis Plow.; P. poarum Nielson. The species marked (†) were studied in connection with this paper.

nata develop spores but few of which show any signs of the digitate processes.

Forming within the host as these spores do, they are under constant pressure because of their own growth and the resistance of the host tissues; hence it is that we may expect to find a large number of malformations. In all the sub-epidermal species studied one-celled forms (figs. 12 *f*, 13 *g*) were found aggregated in the same pustules with the regularly formed teleutospores, but cross sections, vertical to the surface of host, always found them to be located around the borders of the sorus or in places in which an upward expansion was not permitted.

As I did not in any case observe mature spores of this form in portions of the sorus in which there would be freedom of expansion, and as such spores are often found in sori of P. graminis and other eruptive species, which for some reason have failed to tear away the epidermal covering, I take it that these spores are simply dwarfed forms due, perhaps, to a lack of nourishment and excessive pressure at the proper time for the formation of the cross septum. According to this view of formation the term "mesospore"[2] used either according to Sorauer or Dietel is not applicable to these anomalies as found in the species studied (foot-note 1).

As the number in which they appear in relation to the perfect spores is exceedingly variable, not only upon different hosts but in different pustules on the same host, I deem it more probable that their occurrence in these species is due more essentially to local conditions of development than to any hereditary tendency.[3] Certain it is that pressure within the crowded sorus is capable of producing an almost unlimited number of irregularities in the spore forms. Such forms as the one seen at *f*, fig. 13, are always to be found in the borders of the sori, the curvature being due to continued pressure exerted by more internally forming spores. Furthermore, the typical spores of a species are found to arise from the central area of the spore-bed, the position in which the spores

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[2] Winter—Rabenhorst's Kryptogamen Flora, Pilze, vol. i, p. 133.

Sorauer—"Between the uredo and teleutospores one often observes intermediate forms (mesospores) which are really to be considered as simple transition forms." Pflanzenkrankheiten, ed. 2, vol. ii, p. 213.

Dietel—"These spores (mesospores) are not medial between two other spore forms; but the species in which they occur stand themselves intermediate between the two genera, Uromyces and Puccinia." Morphologie und Biologie der Uredineen, p. 6; Botanisches Centralblatt, vol. xxxii, 1887.

[3] This is not given as an explanation of the production of the mesospores as found in such species as *P. vexans* Farlow and *P. sporoboli* Arth., which I have not studied.

are least subjected to irregularites of resistance. In every case the pressure is due to enlargement of the spore during growth, while the adjacent spores and the surrounding tissues, simply through resistance, constitute the moulds which shape the irregularities.

These irregularities in the spores are of two distinct natures, those which arise from an actual moulding of the spore form due to turgidity of growth and inequalities of external resistance and those which are due to an innate molecular condition of the spore wall which permits of inequalities of extension. The latter mode of formation is of an hereditary nature, due to peculiarities of molecular structure effected by the protoplasm of the species in which it occurs; the first is an accident of development.

Herein lies what I take to be the chief structural difference between the species P. coronata and P. rubigo-vera. While the digitate processes upon the spores of the first are normal to the particular parts of the spore membrane, the irregularities in the contour of the spores of the latter are accidental, depending for the particular forms upon the moulding of the young spores and a subsequent thickening of the cell walls.

That the points upon the spores of P. coronata have no constant regularity of form, number or position, does not invalidate this idea. Certain portions of the spore membrane are possessed of greater powers of extension, perhaps by imbibition, and they expand in the direction in which there is least resistance. These points are always to be seen in vertical sections of the sorus extending into depressions in the epidermis and into interstices between the apices of the spores. The position of the points with reference to the spores, as seen from above, is shown in fig. 5.

The Stroma.—In those species in which the teleutospores are truly sub-epidermal during their whole development, they are not formed upon the same spore bed as the uredospores, which necessarily rupture the epidermis, but are aggregated in a new spot under the uninjured epidermis. It is in the completion of this new sorus that the fungus displays a high degree of parasitism in that, when mature, the mat of fungal tissue which surrounds the spores becomes essentially a part of the host. The fungal hyphæ ramify in the host tissues, principally by way of the intercellular spaces (figs. 2, 3 and 4). When a fruiting spot is formed two or more hyphal branches coalesce, as seen in fig. 3, in an intercellular space lying be-

tween the epidermis and the hypodermal layer. This is the beginning of the *stroma*[4] (hymenium, sporenlager, spore-bed, etc.), a mass of fused fungal hyphæ from which the spores arise.

In section, the mature stroma gives the appearance of a regular tissue displaying many large cell-like openings often much larger than the diameter of the ordinary hypha, due to the interstices between uniting filaments and the solution of some of the uniting walls (figs. 2 *b* and 11 *c*).

The fungal filaments not only have the power of uniting themselves with the cell walls of the host by fusion, but probably by the secretion of an unorganized ferment,[5] can penetrate, pass through or wholly dissolve them. Hence it is that the hypodermal host tissues are always to be found closely united (fused) with the stroma and are not distorted, though the pustule, since its formation, has expanded greatly. This quality of fusion is most noticeable in the so-called "paraphyses" which accompany the teleutospores of P. rubigo-vera.[6]

The various descriptions of this species invariably refer to "dark brown paraphyses" intermingled with or surrounding the spores. Burrill also records the same with regard to P. coronata. The bodies are easily found in both species by scraping off the pustules and examining the debris. But their varying tissue-like dimensions, dissimilarity to ordinary paraphyses (compare fig. 6*c* with fig. 7), and the further fact that they are always not only connected at the base with the stroma but also with the epidermis at the top, led me to believe that they could not be paraphyses in the best accepted sense, but were merely vertical extensions of the basal stroma. Furthermore, in all cases in which a microchemical reagent affected these bodies, the action was the same as that for the stroma.

Carefully prepared serial, vertical and tangential sections of the host leaves, passing through the pustules, confirmed the truth of this supposition.

Soon after the coalescence of the filaments which start the new sorus, the young spores appear, developing centrifugally, while the hyphæ which form the spore-bed eat away the host tissues, spread rapidly, and finally enclose the spores on the sides (fig. 2 *b* and *f*), thus, when fused together and with the epidermis at the top, cutting off what may be termed

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[4] For the use of the word see Sorauer, Pflanzenkrankheiten ed. 2, vol ii, p. 212. Also Plowright, "British Uredineæ and Ustilagineæ," p. 36.

[5] Vines, Physiology of Plants, p. 191.

[6] Saccardo, Sylloge Fungorum, vol. vii., part 2, p. 625.

a simple sorus. This development is well shown in the structure of the teleuto-pustule of P. anemones-virginianæ, the fusion of the stromal hyphæ often not being so complete as in other species (figs. 8 and 9). In this species the hyphæ are often seen in cross-section between the simple sori, showing that the vertical position taken by the hyphæ, as usually seen, is in a manner an enforced one, consequent upon the development of the sorus.

A further proof that these hyphæ are not different from the ordinary filaments is found in the fact that when not under pressure at the top they continue to elongate (fig. 8 *b*). The much thickened places on the covering of the pustules in this species are due to these same hyphæ which have passed through the epidermis, forming a fused mass, seen in section fig. 10 *c*. In all the sub-epidermal species on glumaceous plants the sori are found between the leaf-veins, becoming confluent in long lines, while the hyphæ which inclose the simple sori fuse to form the intersorial stromata (fig. 2 *c*) which in thick vertical sections of the compound sorus or pustule give the appearance of the intermixing with the spores of the so-called paraphyses of the descriptions. In vertical longitudinal sections of the pustule, these intersorial stromata are found to be formed across the space between the fibro-vascular bundles in great regularity of position. Whether these structures will be seen in vertical cross sections of the rust pustule depends wholly as to whether or not the space between the fibro-vascular bundles is wide enough for the development of two or more simple sori. From this it will be seen that the ordinary rust pustule of the sub-epidermal forms is not a simple structure as it appears from the exterior, but is compounded of many simple sori; and that the structures lying between owe their form and position merely to a crowding and fusing together of the hyphæ which separate the simple sori and are not separate bodies, paraphyses, but simply extensions of the spore-bed (stroma). That they generally appear as seen at *c* fig. 6 is because an optical section can not reveal the cellular structure. Because of the opacity of the walls and the smallness of the cavities, sections which are to make this structure plain must not have a thickness to exceed 10 μ. In cross section the intersorial stromata appear as strips of regular tissue forming a net-work between the fibro-vascular bundles with which they are connected, while the spores fill up the intervening spaces (fig. 11 *c*). The only apparent difference between this fungal tissue and

the host tissues into which it seems to graduate is its reddish brown color and its ability to resist the action of reagents, macerating fluids, etc.

That the teleutospores are sub-epidermal at maturity is apparently because of the fact that before they have become strong enough to rupture and throw off the epidermis the hyphæ which arise on the sides of the young sorus have fused with and hold that covering in place.

EXPLANATION OF PLATE XV.—Fig. 1. Vertical section through teleuto-sorus of *P. graminis* Pers. on leaf sheath of Triticum vulgare; host tissues in cross-section: *a*, epidermis; *b*, teleutospore; *c*, sclerenchyma; *d*, fungal hypha. × 120.

Fig. 2. Vertical transverse section of young compound teleuto-sorus of *P. coronata* Cda. on leaf of Avena sativa, showing the relation of the young spores to the surrounding tissues and the penetration of the host by the fungal hyphæ: *a*, epidermis; *b*, a portion of the spore-bed (stroma) in section; *c*, the same as found between the simple sori, a so-called paraphysis in vertical longitudinal section; *d*, young spores not yet septate; *e*, nearly mature spore; *f*, beginning of stroma which finally encloses the spores. × 350; section 5 μ thick.

Fig. 3. Portion of a vertical longitudinal section of leaf of Avena sativa, showing very early stage of a teleuto-sorus and intercellular hyphæ: *a*, epidermis; *b*, coalescing hyphæ forming the spore-bed; *c*, hypodermal cell.

Fig. 4. Tangential section of leaf of Avena sativa in hypodermal region passing through the young spore-beds: *a*, hypodermal cells; *b*, basal portions of young spores; *c*, intercellular hyphæ; *d*, hyphæ fused with cell walls and partly in section. Section 5 μ thick; ×350.

Fig. 5. Apices of four mature spores of *P. coronata* Cda. as seen from above, showing form and position of digitate processes. × 680.

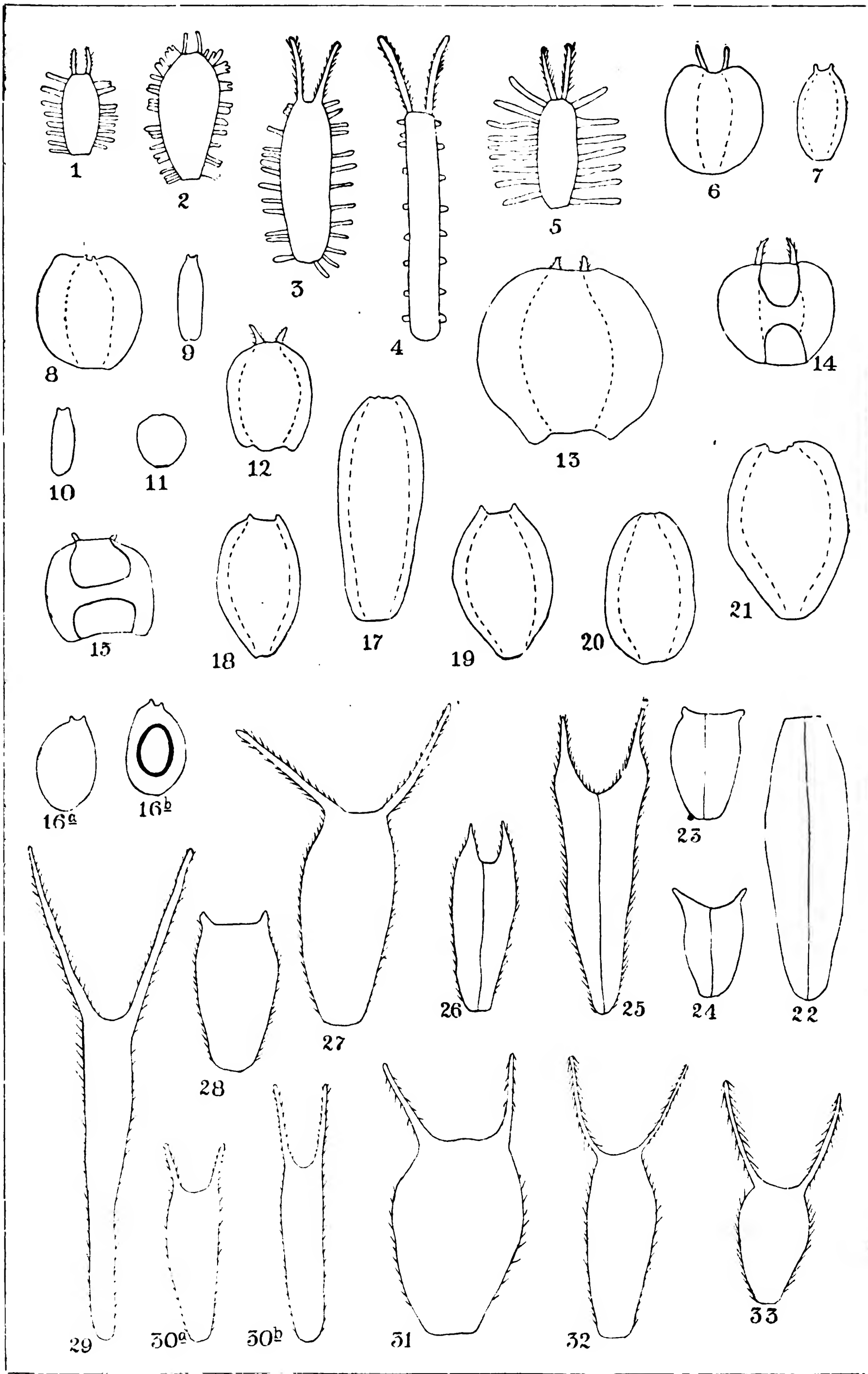
Fig. 6. Spore and *so called paraphysis* in situ; typical form from *P. rubigo-vera* DC. on Hordeum jubatum: *a*, epidermis; *b*, teleutospore; *c*, the "*paraphysis*" (stroma). × 350.

Fig. 7. Two paraphyses from uredo-sorus of *Phragmidium rosæ-alpinæ* DC. × 350.

Fig. 8. Portion of a compound sorus of *P. anemones-virginianæ* Schw. on Anemone patens, showing intersorial stroma in section, *c-a*; *b*, hypha passing over apices of spores; *d*, hypha beneath the spore-bed; stroma and epidermis fused at *a*. × 200.

Fig. 9. Same as fig. 8; hyphæ which form the intersorial stroma not completely fused: *a*, epidermis; *b*, hypha; *c*, spore. × 200.

Fig. 10. Left corner of sorus of P. anemones-virginianæ: *a*, epidermis of host; *b*, hypha partly fused with epidermis; *c*, coalescing hyphæ; *d*, spore. × 200.



ROSE on COREOPSIS.

Fig. 11. Tangential section of leaf of Avena sativa cutting a compound sorus of P. coronata midway between spore-bed and epidermis: *a*, teleutospores in cross-section; *b*, cells of fibro-vascular bundle; *c*, intersorial stroma in cross-section. Section 5 μ thick. × 350.

Fig. 12. Teleutospores of P. rubigo-vera on Triticum vulgare from Ellis' "North American Fungi" No. 1471, showing variations in size and form upon the same host: *a*, *b*, type spores; *c* and *d*, spores bearing short points at apices; *f*, a one-celled spore. × 350.

Fig. 13. Teleutospores of *P. coronata* Cda. on Avena sativa from one host: *a* and *b*, type spores; *c*, *e* and *f*, forms often found; *d*, truncated spore; *g*, two mesospores and a teleutospore from corner of sorus. × 350.

Indiana Experiment Station, Lafayette.

Achenia of Coreopsis.

J. N. ROSE.

(WITH PLATE XVI.)

Coreopsis shows as great a variety of achenia as any genus of Compositæ, but they are hard to define. They may be flat or somewhat 4-sided, straight or curved, orbicular to linear-oblong in outline, glabrous to pubescent, winged or wingless, with entire or laciniate-toothed margin, apex truncate or emarginate, pappus of two awns (sometimes more) or of teeth or scales, these generally upwardly hispid (often naked), or all these wanting. The genus is not clearly separated from Bidens, for while the one is said to have its awns always upwardly hispid, and the other downwardly hispid, several species in each hybridize freely and break down this distinction. While the genus possesses such a range of fruit structures, and by this alone one can not always distinguish species as now defined, it enables natural groups of a few species to be easily formed, and most of these can then be separated by leaf characters. In some cases it seems questionable whether these sub-divisions should be made, for they embrace so many intermediate forms that no line can be clearly drawn between them. No attempt has been made in this paper to combine species, with the belief that Dr. Gray in his Synoptical Flora has given the most satisfactory arrangement that can now be made. His lineal order has been followed in

the main, and little variation from his descriptions has been made, except in greater fullness and when new material has brought to light additional characters since the publication five years ago. So far as I am aware, no attempt has been made to illustrate the achenia of Coreopsis, and this paper is presented with the hope that it will aid botanists in determining the species of this genus, as we all know that a good drawing is scarcely less helpful than the specimen itself.

I have not gone into the troublesome question of nomenclature, although several changes have been suggested. The achenia vary so much sometimes in the same species, or even in the same head, that a single drawing is not sufficient for proper illustration: for example, figures 3 and 4 are from the same head. Other species are quite constant and can be recognized at a glance.

I have consulted the following herbaria in the preparation of this paper, and am indebted to those having them in charge for kindly putting them at my disposal: Private collection of Mr. Wm. M. Canby; Columbia College collection (Dr. Torrey's plants), sent by Dr. N. L. Britton; Wabash College Collection, sent by Prof. John M. Coulter; and the National Herbarium at the Department of Agriculture, in charge of Dr. George Vasey, who has also been a source of help in other ways.

§ 1. Achenia not villous-ciliate, with no callus on inner face, often papillose-roughened.

*** Achenia straight, with fimbriately dissected wings, 2 awns, smooth or slightly papillose-roughened.**

C. nudata Nutt. Achenia oblong, 1-1½ lines long, smooth; the dissected wings but half as broad as body; awns mostly prominent. (Fig. 1.)

Dr. Gray, in Synopt. Fl., describes the awns as "two short subulate awns," and Torrey & Gray speak of "awns scarcely exceeding the wing of the achenium," while the recent collections of Chapman and Curtiss, from Apalachicola, Fla. (the original station), have awns prominent and exceeding the wing, often appearing more striking than shown in fig. 1. This species seems more closely related to the two following than to C. rosea, which it resembles only in the color of the rays and disk flowers. Thus arranged, we have a group of 3 species differing from every other Coreopsis in their peculiarly dissected wings. The drawing is from Curtiss 1484, collected near Jacksonville, Fla.

C. gladiata Walt. and *C. angustifolia* Ait. are two very closely related species, and many intermediate forms are very puzzling. The achenia do not give very reliable characters, for they vary much even in the same head, and have nothing very constant about them. Fig. 2, perhaps, represents a typical achenium of C. gladiata as considered by Gray in Synopt. Fl., with its short awns and pectinate fringe. Fig. 3 is a good representation of C. angustifolia, with its narrow fimbriate wings and slender setiform awns. Fig. 4 does not look much like the last, but is from the same head near the center. Fig. 5 represents the other extreme, with wing broader than body. The achenia of these species are linear-oblong to obovate-oblong, 1½-2 lines long, smooth or papillose-roughened. Fig. 2 is from J. D. Smith's collection of 1883, near Columbia, S. C. Figs. 3 and 4 are from Dr. A. P. Garber's S. Fla. collection, distributed as C. gladiata. Fig. 5 is from G. McCarthy's collection of the past season, near Augusta, Ga.

C. integrifolia Poir. has been referred to this section, but has never been collected in fruit.

** Achenia incurved, with scarious entire wings, minute awns (except in C. Leavenworthii), smooth to tuberculate-roughened.

C. Leavenworthii Torr. & Gray. Achenia oval, 1 line long; wings as broad as body; awns slender, prominent. (Fig. 6.)

Drawing from Curtiss 1480.

C. Atkinsoniana Dougl. Achenia oblong, 1 line long by ½ line wide, smooth; wings very narrow, often a mere margin; pappus of two small teeth, or obsolete. (Fig. 7.)

Drawing from Howell's collection.

C. cardaminefolia Torr. & Gray. Achenia oval to oblong, 1 to 1½ lines long, smooth or slightly papillose; wings almost as broad as body, sometimes almost as narrow as the preceding; pappus wanting or two very small teeth. (Fig. 8.)

Drawing from Wright's New Mexican collection of 1851.

*** Achenia minute (smallest of the genus), more or less incurved, wingless, awnless, smooth or slightly papillose.

C. tinctoria Nutt. Achenia linear to narrowly oblong, a line or less long, thinnish. (Fig. 9.)

The achenia are much like the following, as shown by the figure. Drawing from Wright's collection of 1849.

C. rosea Nutt. Achenia linear-oblong, less than a line long, thinnish, almost straight, slightly ribbed on inner face. (Fig. 10.)

Drawing from Britton's Long Island collection of 1872. I have transferred C. rosea so as to follow C. tinctoria. Although it has characters which relate it to C. nuda, for our purpose it seems best to consider it in this section. The fruit and habit are so similar that it seems unnatural not to consider it as belonging here.

C. Drummondii Torr. & Gray. Achenia oval to obovate, half a line in diameter, thickish, wingless but with a cartilaginous margin. (Fig. 11.)

The achenia are unlike any others of the genus, but curiously enough the species has been much confused in collections. Drawing from Reverchon's collection, distributed as C. tinctoria.

§ 2. Achenia not villous-ciliate, with a large callus generally developed at each end of inner face.

*** Wings thin and broad; pappus two small teeth.**

C. coronata Hook. Achenia oval, 1 to 2 lines long, smooth or tuberculate; wings from half to as broad as body; pappus two short or prominent teeth. (Figs. 12 and 13.)

Considerable variation is found in the size of the achenia, breadth of wings, and length of pappus. Fig. 12, from Drummond's collection, has the wings narrow, as described by Torrey & Gray; while fig. 13, from Hall's collections, is the more common form.

C. Harveyana Gray I have not seen.

C. grandiflora Nutt., and its two related species *C. lanceolata* L. and *C. pubescens* Ell., can not be separated upon fruit characters with the specimens at hand. Collectors have almost universally neglected to collect them in fruit, and our material has largely been obtained from old collections. Dr. Gray considered that the species were probably confluent, and the nearly identical achenia and similarity of foliage seem to confirm this. Especially is this true of C. grandiflora and C. lanceolata. *C. pubescens* Ell. in the Syn. Flora is said to have (like C. lanceolata) the pappus very small or obsolete (as in fig. 15), but Curtiss 1485 has awns as long as those of C. grandiflora Fig. 14 is C. grandiflora from Bigelow's collections in 1853, Fort Smith, Ark. Fig. 15 is C. pubescens from McCarthy's collection of 1888.

** Wings narrow, involute and very thick; pappus minute or none.

C. auriculata L. is well marked by its achenia, although it resembles C. pubescens very much in its vegetative characters, under which species it was placed by Torrey & Gray. The achenia are very smooth, a line long by half line broad, tuberculate, incurved; wings narrow, involute and thickened, making the achenium boat-shaped. (Fig. 16 *a* and *b*.)

Fig. 16 *a* is the back view of an achenium, and 16 *b* the front view, the inner ring being the thickened involute margin. Drawing from Curtiss's Virginia collection.

§ 3. Achenia oblong, often villous-ciliate, with no callus on inner face, not papillose-roughened.

* Achenia with narrow wings, flat and smooth.

The first five species, belonging to § *Eucoreopsis*, form a closely related group, and though generally easily separated by leaf characters the fruits vary but little. They all have small achenia, which are more or less incurved, with narrow scarious wings and small or obsolete awns.

C. palmata Nutt. Achenia oblong, with narrow wings and obsolete awns. (Fig. 17.)

C. verticillata L. has oblong to obovate-cuneiform achenia with minute awns. (Fig. 18.)

C. delphinifolia Lam. has achenia somewhat broader than the last, from which it can not well be separated upon fruit characters alone. (Fig. 19.)

C. senifolia Michx. is much like the preceding, but the achenia (2 lines long) are not so narrow at base, oblong or elliptical in outline, and awnless. (Fig. 20.)

A specimen collected by Dr. and Mrs. Britton has achenia 2½ lines long and 1½ lines broad. In 1885 the same botanists collected at Black Mt. Station a form which is probably what Elliott described as C. Œmleri, but which Dr. Gray, in Synopt. Flora, considered the "abnormal entire-leaved form" of C. senifolia var. stellata. It does not accord well with the form examined, and seems to approach forms of C. tripteris. The achenia are more oval than in C. senifolia.

C. tripteris L. Achenia obovate, broader than the preceding, emarginate at apex. (Fig. 21.)

Drawing from Prof. T. C. Porter's collection of 1868.

** Achenia wingless, somewhat angled, often ciliate on margin.

C. latifolia Michx. is as readily distinguished from its related species by fruit characters as vegetative. Achenia (3

to 4 lines long) narrowed each way from above the middle, the base being narrower than the truncate apex, often stronger ribbed on the outer face, giving a triangular shape, quite glabrous; no awn or pappus of any kind. (Fig. 22.)

Specimens of this species are very rare in collections. The only fruiting specimen found, and from which the drawing was made, was collected by Dr. Gray in 1843. Good specimens are very much desired by the Department of Agriculture.

C. aurea Ait. in its typical form is easily distinguished by its fruit characters, but in some of its varieties approaches the next. Achenia short (1 to 2 lines long), broadly cuneate, slightly pubescent; awns two short broad teeth or wanting. (Fig. 23.)

Drawing from Curtiss' Georgia collection of 1875.

In the var. subintegra, as shown by Chapman's plant (Columbia Coll. Herb.), the awns are longer, acute and spreading and resemble some forms of C. trichosperma. (Fig. 24.)

C. trichosperma Michx. is rather well marked in its fruit characters, although it presents various forms, some approaching C. aristosa on the one hand and C. aurea on the other. Achenia 2 to 4 lines long, a line or less broad, slightly pubescent or glabrous, ovate-oblong to cuneate-oblong; awns broad at base, terminating in a short acumination, erect or turned inward. (Figs. 25 and 26.)

Short's plant from Kentucky and Hall's from Kansas have narrow achenia, approaching certain forms of the next.

***** Achenia very flat, wingless but with thin margins.**

C. aristosa Michx. is not easily defined as it grades almost insensibly into several related species on the one hand and crosses so commonly with various species of Bidens on the other. It seems almost impossible to draw any specific or generic lines about it. Achenia very flat, sometimes slightly ribbed on the faces, 3 lines long, oblong to obovate; awns generally quite long, sometimes equalling the achenium and spreading, but in the var. mutica obsolete or nearly so. (Figs. 27 and 28.)

Fig. 31 is from J. Q. A. Fitchey's plant, collected in 1859 at St. Louis, Mo., and considered by Dr. Gray as a hybrid from this species and Bidens chrysanthemoides. Fig. 32 is from a plant collected in 1873 by Dr. F. Brendel of

Peoria, Ill. It is evidently a hybrid from this species and Bidens frondosa. The awns are downwardly barbed, and the marginal hairs upwardly turned, as in B. frondosa, while the rays and leaves are those of C. aristosa.

C. involucrata Nutt. is said to have achenia with two short acute teeth, but was not seen. It is closely related to the last through its variety. Fig. 33 is probably a hybrid from this species and Bidens frondosa, collected by G. H. French in Ill., in 1878.

C. bidentoides Nutt. Achenia linear to narrowly cuneate, 4 to 5 lines long (largest of the genus), with two prominent awns ½ to ⅔ their length, slightly spreading, and minute awns from the lateral angles. (Fig. 29.)

Dr. Vasey collected near Washington, D. C., Sept. 23, 1888, a peculiar hybrid from this species and Bidens connata, which has the awns of both Coreopsis and Bidens, that is, they are hispid upward or downward or both ways.

C. discoidea Torr. & Gray. Achenia linear-oblong to cuneiform, 2 to 3 lines long; awns more or less prominent, erect or slightly spreading. (Figs. 30 *a* and 30 *b*.)

Explanation of Plate XVI.—All drawings ×10. Fig. 1. C. nudata. Fig. 2. C. gladiata. Figs 3, 4, 5. C. angustifolia (the first two from the same head. Fig. 6. C. Leavenworthii. Fig. 7. C. Atkinsonia. Fig. 8. C. cardaminefolia. Fig. 9. C. tinctoria. Fig. 10. C. rosea. Fig. 11. C. Drummondii. Figs. 12, 13. C. coronata. Fig. 14. C. grandiflora. Fig. 15. C. pubescens. Fig. 16*a*, 16*b*. C. auriculata. Fig. 17. C. palmata. Fig. 18. C. verticillata. Fig. 19. C. delphinifolia. Fig. 20. C. senifolia. Fig. 21. C. tripteris. Fig. 22. C. latifolia. Fig. 23. C. aurea. Fig. 24. C. aurea, var. subintegra. Figs. 25, 26. C. trichosperma. Fig. 27. C. aristosa. Fig. 28. C. aristosa, var. mutica. Fig. 29. C. bidentoides. Fig. 30*a*, 30*b*. C. discoidea (from same head). Fig. 31. C. aristosa × Bidens chrysanthemoides. Fig. 32. C. aristosa × Bidens frondosa. Fig. 33. C. involucrata × Bidens frondosa. Figs. 11, 14, 15, 16*b* represent the ventral side; all others show the dorsal.

Department of Agriculture, Washington, D. C.

BRIEFER ARTICLES.

Sensitive stamens in Compositæ.—It is well known that the flowers of several species of Compositæ are sensitive, among the leading of which are the centaureas and thistles. This fact, together with the great similarity of floral structures, has led me to look for movements in other species. Considerable quantities of the flowers to be studied were collected,

placed in a deep glass vessel filled with water, and set where there would be plenty of light and warmth, but to the exclusion of all insects naturally visiting such blossoms. After a few hours a jar was placed upon a table and the flowers inspected for sensitiveness. A large bull's-eye condenser was adjusted upon its tall stand so that a head of flowers came into full view. Then, with the eye intent upon the particular blossom, the various floral parts were touched with the point of a needle.

By this method the first reward was Echinacea angustifolia. In this the whole flower, when touched upon one side, will move in a direction opposite to that of the irritant; that is, if pushed by the needle upon the south side, the top of the flower will move south, and through a distance averaging its own diameter. At the same time there is a contraction or drawing down of the ring of anthers equal to one-half of the diameter. This motion takes place quickly and leaves the lemon-colored pollen exposed upon the tip of the style, which may already extend somewhat above the anther-ring. Unusually good results are obtained with flowers which as yet show no portion of the style. In such the ring will contract and show the first pollen in profusion upon the extremity of the style. After an hour or so the flower again becomes irritable, and the anthers will retreat farther, leaving a fresh supply of pollen exposed upon a lower section of the style. The contraction is such that in many instances there is a revolving motion to the flower, as has often been seen in the thistle. In the Echinacea there are none of the peculiar hairs exhibited by the thistle filament, the surface being smooth throughout.

The observations which have been stated for the Echinacea hold true in a general way for Heliopsis lævis, although there are minor differences not worthy our present attention.

A third species to be added to the list of sensitive flowers is Lepachys pinnata, and a fourth is Rudbeckia hirta.

With a good triplet and upon a bright hot day fair results may sometimes be obtained in the field, but as insects are usually abundant the laboratory method is much more satisfactory. The writer would be pleased to learn what other Compositæ have been found in this country illustrating sensitiveness of the stamens.—BYRON D. HALSTED, *Rutgers College, New Brunswick N. J.* [Mr. Thomas Meehan has investigated this matter at considerable length, but ascribes the movements to elasticity and not sensitiveness. See abstract of his paper in Proc. A. A. A. S., Phila. meeting, papers in Proc. Phila. Acad., and various abstracts and notes in this journal.—EDS.]

Peronospora upon cucumbers.—On May 8th, while taking a run through the greenhouses and grounds of Mr. J. T. Hill here in New Brunswick, my attention was attracted by the numerous light patches upon the leaves of some cucumber vines which were growing in a hot-bed and already bearing fruit suitable for the table. Upon examining these spots they were found to be due to a growth of some species of the genus Per-

onospora. From the fact that *Peronospora australis* Spegaz. grows upon Sicyos angulatus, another member of the cucumber family of plants, one naturally turned to that as given in Ellis' N. A. F. No. 1416 for comparison and verification. The conidiophores and conidia are surprisingly different from the Sicyos species, and the patches of mildew as a natural consequence have a different aspect. Attempts have been made to germinate the conidia, but as yet without success. The oospores have not been met with.

This note is introduced here that students of this destructive group may be upon the watch for the cucumber mildew and its present range determined. From the nature of the fungus, and the plant upon which it is found, it is to be feared that market gardeners may have in the cucumber mildew a serious enemy, especially should it spread to squashes, melons and other members of the Cucurbitaceæ, and attack the seedling plants.—BYRON D. HALSTED, *Rutgers College, New Brunswick, N. J.*

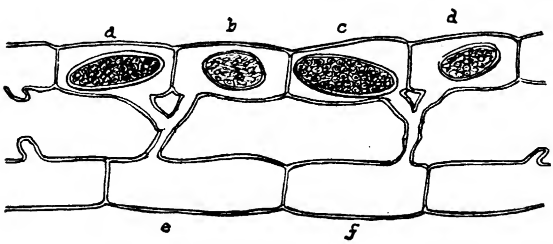
Lactuca Scariola L.—I first noticed this plant in the summer of 1885 in the corner of an abandoned vegetable garden, and in the adjacent street, near my home on 71st street. It has since spread along the street for a couple of blocks, and is well established. I have not seen it elsewhere in the vicinity of Chicago.—E. J. HILL, *Englewood, Ill.*

Aster ptarmicoides, var. **lutescens** Gray.—In the BOTANICAL GAZETTE for 1883 (Vol. VIII, p. 238), an article by me appeared entitled "Aster or Solidago." It was based on a study of some plants found at Englewood nearly like A. ptarmicoides, but with pale yellow flowers. The question was raised whether it might not be a hybrid. This supposition proved to be wrong, for, specimens being sent subsequently to Dr. Gray, he identified it as given above, and it was thus published in the "Synoptical Flora." The article closed with the statement that the plant might throw some light on the *Aster lutescens* of "Torrey and Gray's Flora of North America," which Douglas collected in British America, near the Assiniboine river, as it seemed quite near that species. This conjecture, it seems, turned out to be true.

But the habitat here is at a great distance from that, and I do not learn that it has been found elsewhere in the United States. Macoun (Catalogue of Canadian Plants), under *A. lutescens* Torr. & Gray, states that it grows by the Assiniboine river, on the authority of Douglas, and on his own authority says: "west of the Touchwood Hills, 1872, not detected since." Gray, in the "Synoptical Flora," says, "Red river." But the Assiniboine and Red rivers unite in Manitoba a little before flowing into Winnepeg Lake, so that the region is essentially the same. The Touchwood hills are about 500 miles farther west, near the upper waters of the Assiniboine. I find no mention of its occurrence in other places. In his "Catalogue of the Flora of Minnesota" (1884), Warren Upham, referring to its presence in Northern Illinois, says: "it will probably be found in Minnesota."

It is the rarest of plants here. The locality where it was first seen is now on one of the main business streets of Englewood, and mostly covered with buildings. I afterwards found a few plants about a mile farther south, at Normal Park, and transplanted some of them, as the locality was rapidly passing into the hands of those building residences. But one of these plants is now living, a vigorous specimen, and with rather larger flowers than when planted, as if cultivation agreed with it. I have looked for plants every summer since these were taken up (1886), but so far without finding them. It grows in company with the typical A. ptarmicoides, which is everywhere abundant in the dry grounds here. But the plant in my garden is the only one I know to be existing this side of British America, though I shall still continue the search for it. I should expect the connection of these widely separated localities to be by way of Lakes Michigan and Superior. Several years ago I found a somewhat similar case, an isolated patch of a malvaceous plant, *Sphæralcea rivularis* Torr., on an island of the Kankakee river. Its home is in the far west, "W. Wyoming, northward and westward" (Coulter's Manual of Rocky Mountain Botany). In a notice of this plant, in the "American Journal of Science" (3, vii, 239), Dr. Gray gave his opinion as follows: "Unexpected as the discovery is it is not difficult to see how the species may have got there. A good many northwestern plants occur on the shore of the southern end of Lake Michigan, evidently through water transport. Some of these may have come in recent times, although this could not be inferred simply from the fact that they have not been noticed until lately. Here is one which probably came so long ago as when Lake Michigan discharged into the Mississippi, the lower part of the Kankakee river being in the direct course of the discharge. The present plants may more probably be regarded, not as chance stragglers, but as lingering remnants indicating an ancient habitat." When the Aster was sent, he expressed similar views regarding its presence here.—E. J. HILL, *Englewood, Ill.*

A phase of conjugation in Spirogyra.—The accompanying illustration was made from a camera lucida drawing of a phase of polygamy in Spirogyra longata which was put in alcohol in May, 1888. It completes the history of the phase suggested by Rose's nos. 10, 11 and 12, vol x, page 304, of the GAZETTE.



The contents of *e* seem to have passed into *a* and *b* and a zygospore has been formed in each. That in *a* is larger and darker than the one in *b*. The same is true in *c* and *d*.—C. B. ATWELL, *Evanston, Ill.*

CURRENT LITERATURE.

The Rusts and Smuts.

The rusts (Uredineæ) and smuts (Ustilagineæ) have for a long time been favorite objects for collection and study by botanists. The former, especially, have attracted much attention both on account of their neat and varied spore forms and the readiness with which in general they may be distinguished by the hosts on which they grow. It is significant also that we owe one of the most interesting chapters in the study of the life history of fungi to the economic relation of rusts to agriculture. It is fitting that such well marked and interesting groups should receive independent treatment, and the assertion is abundantly substantiated by a recent work which lies before us. This is Mr. Charles B. Plowright's[1] account of the British species of these two groups, prefaced by a statement of the general conditions of their development and of their experimental cultivation.

There has always been a curious association of the rusts and smuts in the minds both of the public and of the scientist, although it has not yet been shown that they have any actual relationship that might justify it. Mr. Plowright's book would doubtless have been just as acceptable with the smuts omitted, although cutting out nearly one-fourth the pages and one-half the illustrations, for he has added little to what was already well known about them.

The chief interest of the volume lies in the part on the rusts, and the treatment is so satisfactory as to amply justify the publication in book form. The publisher's part has been well done, if one is inclined to accept the liberal use of heavy paper, wherein we detect a willingness to expand two dollars' worth of matter into a four dollar volume, as is the custom with certain American firms.

Every one of the seventy pages on the biology and experimental treatment of the rusts shows the author's intimate knowledge of his subject gathered from extensive independent research. He tells us of the mycelium, of the several spore forms and their significance, of the remarkable history of heterœcism, and of his own excellent methods of spore culture. This he does concisely and by the use of admirable diction. Any one who is studying, or thinks of studying, these fungi will find this part of the work of unusual interest and importance.

After the biological part, occupying about one-third the book, comes the systematic treatment of the British species. The arrangement of the rusts is essentially that proposed by Schröter, but the position of many

[1] PLOWRIGHT, CHARLES B.—A monograph of the British Uredineæ and Ustilagineæ, with an account of their biology, including the methods of observing the germination of their spores and of their experimental culture. pp. 347, 13 wood cuts and 8 plates. 8vo. London: Kegan Paul, Trench & Co., 1889. 10 s. 6 d.

of the species has been determined by Mr. Plowright's cultures. The biological notes appended to the description of many of the species are particularly important, and give evidence of the author's careful and extensive research.

No more need be said for the illustrations than that they are well executed.

Those familiar with the subject need not be told that this work, owing to the large number of species common to the United States and Great Britain, is almost as serviceable to American botanists as to the English.

A New Text-book of Botany.[2]

This is the day of text-books, and an active botanist seems hardly to have done his duty until he has prepared a text-book, a laboratory guide, or at least a scheme for plant analysis. The book before us is a revised and enlarged edition of the "Elements of Botany," recently published by the same author, and contains "organography, vegetable histology, vegetable physiology and vegetable taxonomy, with a brief account of the succession of plants in geologic time, and a glossary of botanical terms." Attempting, as it does, to cover nearly the whole field of botany, there can be no elaborate discussion. The author has prepared his text with great care, and has brought together in compact shape much that is best in modern botany. If we were inclined to point out defects in this really painstaking book, we would say that the illustrations are not all they might be. Many of them are copies from standard figures, and would have looked better if they had been reproduced by some photographic process rather than redrawn. But this is a minor matter, when the figures are accurate. In the illustration on page 197, however, we have a transverse section of a leaf in which the stomata are shown in surface view, a thing that is apt to be misleading. The book is a useful one and will serve its purpose well.

Minor Notices.

PROF. C. S. SARGENT has done good service to botanists by editing portions of the journal of André Michaux. It is published by the Amer. Philosophical Society in a pamphlet of 145 pages. The editor acknowledges the great assistance rendered by Mr. John H. Redfield, for without it "the publication would never have been begun, and could not have been finished." The journal is more than a diary of travel, for it contains much valuable information concerning the plants discovered, and the condition of remote settlements as an intelligent traveler saw them in the last century.

[2] BASTIN, EDSON S.—College Botany. 8vo., pp. xv, 451, with nearly 600 illustrations Chicago: G. P. Engelhard & Co., 1889. $3.00.

DR. WM. TRELEASE has published the results of his study of Ilicineæ and Celastraceæ.[3] The paper is intended more as a call for additional information than as a completed synopsis. In Ilex no change of nomenclature is proposed except the reduction of I. myrtifolia to a variety of I. Dahoon. A new species of Euonymus from S. California is described. A notable feature of the paper is that it includes notes on the biology and paleobotany of the groups considered.

ILLUSTRATIONS of West American Oaks, from drawings by the late Dr. A. Kellogg, has just been published in San Francisco. Prof. E. L. Greene has prepared the text, while the funds for this elaborate quarto pamphlet of over 50 pages and 24 plates have been provided by James M. McDonald, Esq. A sketch of the life and work of Dr. Kellogg is given by Mr. George Davidson, while an introductory account of oaks in general is from the pen of Prof. Greene. The work is a most commendable one, and the careful sketches of this difficult group made by an acute observer are better than any amount of verbal description. Professor Greene has also done his work well, and given us a careful account of the bibliography and range of the species. The new species proposed are Q. MacDonaldi, Q. Engelmanni (*Q oblongifolia* Engelm. in part), and Q. turbinella.

WHAT SHALL constitute a species, is even a more puzzling question among bacteriologists than it is to the phænogamist. Dr. Trelease stated his views on this question recently to the Alumni Association of the St. Louis Medical College, and his address is printed in the *Weekly Medical Review*, xix. 309. Morphological characters, with proper allowances, including the mode of growth in solid cultures and the behavior of the cells towards staining fluids are of prime importance. Physiological characters (such as pigment production, specific fermentation and liquefaction of gelatine) are apparently reliable. Pathogenic characters are too unreliable to render species which depend on them above suspicion.

A VERY interesting address is that from the same gentleman on Myrmecophilism, delivered as retiring president of the Cambridge Entomological Club.[4] The author considers the functions of extra-nuptial nectar-glands, the occasional ant-domiciles on plants, and myrmecophilous plants proper. The paper deals so much with details that it is impossible to summarize it. It is accompanied by a bibliography of the important papers on this subject.

PROFESSOR PENHALLOW has endeavored to bring together in a connected form the more important facts relating to the development of botanical science in Canada.[5] The first 266 years, *i. e.*, from the first

[3] Trans. St. Louis Acad. Science, v, 343–357.

[4] Reprint from Psyche, 1889, pp. 171–180.

[5] PENHALLOW, D. P.—Review of Canadian Botany from the first settlement of New France to the nineteenth century. Part I. From the Trans. Roy. Soc. Can., v. 4, 45–61. 4to. Montreal: Dawson Bros. 1888.

voyage of Jacques Cartier to New France to 1800, was a period of very slow scientific progress, and the names of those who in any way contributed to botanical work in Canada do not exceed 24. Regarding these the author gives much interesting information, with notices of their work. It is evident that it has taken much time and labor to search out these facts, and the thanks of the antiquarian, as well as the historian and botanist, are due to Professor Penhallow.

An important contribution to the knowledge of the moss-flora of New Guinea forms the last issued part of the Bibliotheca botanica.[6] The collections on which it was based were made by Bäuerlen in 1885 in the south, by Chalmers and Bridge in the Cloudy Mts. in 1884, and by Lawes in the Astrolabe Range. Eighteen new species are characterized and eight figured on the beautiful plates. An appendix enumerates the Hepaticæ of the same collections, including one new species.

Cypress "knees" have long been of special interest to morphologists. Dr. W. P. Wilson found favorable opportunity to study these structures while in Florida. A preliminary notice[7] describes two modes of formation, (*a*) by growing upward of young roots till they reach the air and then turning downward again, the knee forming at the angle; (*b*) by local outgrowths from the upper surface of old horizontal roots. Similar ærating organs were caused to form on Indian corn by keeping the soil saturated. They were also observed on Pinus serotina, Nyssa aquatica and Avicennia nitida.

OPEN LETTERS.

Flowers and Insects.

I have been much interested in Mr. Robertson's article on Flowers and Insects. Under Dicentra Cucullaria he refers to observations of others and myself in regard to the puncturing of the corolla by bees. I am pretty sure that the holes were made by honey-bees, as a large hive is in the next yard to mine, and my flowers constantly visited by its occupants. I have observed the same puncturing this year in my yard and that of Mr. George Hunt. It should be stated, however, that Dicentra is not indigenous here, and is only seen in cultivation. In the wild state it may, for all I know, be untouched. W. W. Bailey.

Providence, R. I.

The National Herbarium.

In the Gazette for April an allusion was made to the National Herbarium, which, perhaps, was not sufficiently definite. An arrangement

[6] Geheeb, Adelbert.—Neue Beiträge zur Moosflora Neu-Guinea. Bibl. bot., heft 13. Pp. 12. pl. 8. 4to. Cassel: Theodor Fischer. 1889. M. 10.

[7] Wilson, Wm. P.—The production of ærating organs on the roots of swamp and other plants. Proc. Acad. Nat. Sci. Phila. Apr. 2, 1889. 8vo. pp. 3.

was made, some time ago, between the Secretary of Agriculture and the Secretary of the Smithsonian Institution, by which the botanical collections of the Department of Agriculture and the botanical collections of the Smithsonian Institution in the National Museum were practically united to constitute the National Herbarium, and were placed under the care of the botanist of the Department of Agriculture. There is no present transfer of the herbarium of this department, but whenever the Smithsonian Institution secures a new fire-proof building, special provision will be made for bringing the two collections together.

The appropriation for herbarium work has been increased and valuable collections of plants are now being made in various parts of the country. We hope in time to make the herbarium worthy of the name of National. At the same time we hope to form such relations with the agricultural colleges of the country as will be for mutual benefit. We hope also, through exchanges, to enlarge our representation of foreign plants. We shall be glad of the aid of botanists throughout the country in the way of donations or exchanges of desirable plants, especially of those of distant or unexplored sections. GEO. VASEY.

Washington, D. C.

NOTES AND NEWS.

GEO. R. VASEY is collecting in E. Washington Terr. for the Department of Agriculture.

THIS YEAR is the centennial of the introduction of the chrysanthemum into Europe and of the dahlia into England.

AN ENDEAVOR is being made to establish a fund f r the promotion of botanical research in memory of the late Dr. Leitgeb of Graz.

A BIOGRAPHICAL sketch of the late Ernst Rudolph von Trautvetter, by F. G. von Herder, has just been published in the *Botanisches Centralblatt.*

A SPECIMEN of Podophyllum has been received from John M. Snider of Dayton, Ohio, which consists of a flowering stem without leaves or leaf scars, and also has the stamens united.

MR. J. REYNOLDS VAIZEY, of Cambridge University, England, a young botanist of much promise, is dead. Some of his best writings appeared in the first volume of the Annals of Botany.

A SHORT ARTICLE on potato scab, giving a resumé of present known facts, is contributed by Prof. Jas. E. Humphrey to the sixth Annual Report of State Agric. Expr. Station at Amherst, Mass.

DR. ANTOINE MOUGEOT, a well-known cryptogamic botanist of France, died February 20, at 74 years of age. He was one of the charter members and the first secretary of the *Société Mycologique de France.*

DR. C. F. MILLSPAUGH is publishing a series of articles on our native medicinal plants in the *Homœopathic Recorder.* The recent numbers contain plates and descriptions of Epiphegus Virginiana and Viburnum Opulus.

DR. SERENO WATSON was elected a member of the National Academy of Sciences at the recent meeting in Washington. The number of members is now one hundred, the limit fixed by the laws of the Academy, although never before attained.

DR. N. L. BRITTON (*Torr. Bull.* May, 1889) has published a preliminary note on the N. American species of *Tissa* Adans., or the sand spurreys, which have heretofore appeared variously as Spergularia, Lepigonum, etc. Ten species are enumerated.

THE ARTICLE by P. H. Dudley on the fungi destructive to wood' printed with the botanist's report in the 41st annual report of the New York Museum, has been translated into French, and appears complete with the illustrations in the *Revue Mycologique* for April.

PROFESSOR THOMAS MEEHAN has just distributed his fourth "Contribution to the life histories of plants." It contains notes on secund inflorescence, Pinus pungens and its allies, Corydalis flavula, dimorphism in Polygoneæ, nature and office of stipules, and Euonymus Japonica.

THE SOCIÉTÉ de Physique et d' Histoire Naturelle of Geneva has offered a prize of 500 francs for the best monograph of a genus or family. The manuscript, which must be written in Latin, German, French or Italian, must be sent to the president by the 1st of October of the present year.

PEACH and apricot stones (endocarp and seed) are used in California for fuel, the former bringing $6 a ton and the latter somewhat less. They were formerly waste products of the great fruit-preserving establishments. Peach stones are considered equal to the best California coal for domestic use.

A BIBLIOGRAPHICAL DIRECTORY of American agricultural scientists has been issued by Prof. C. S. Plumb. It contains over two hundred names chiefly those connected with experiment stations. The work is carefully compiled and neatly printed, and will be of interest and service to those interested in the scientific progress of agricultural knowledge.

THE SACRED LOTUS, Nelumbium speciosum, has become established in a pond in New Jersey, and proves hardy, although the surface of the water is frozen over during the winter. The history of its planting, by E. D. Sturtevant, is given in *Garden and Forest* for April 10, with a fine photo-engraving of the spot showing hundreds of open flowers.

THE WIDE FIELD that still remains for research among the mosses of North America is indicated by a comparison between a recent catalogue of the moss-flora of the neighborhood of Geneva, Switzerland, and the known species of this country. Guinet's catalogue contains 465 species and 114 varieties, while our total of recorded species does not much exceed 1,000.

ZOPF HAS discovered a new species of Saccharomyces which he has named after the most distinguished student of this group S. Hansenii. This yeast, instead of producing alcoholic fermentation, causes the formation of oxalic acid from such various substances as grape, cane and milk sugars, galactose, maltose, dulcite, glycerine and mannite. It forms ascospores after the fashion of S. cerevisiæ, but one or two only.

FOR A LONG TIME attempts have been made to place the control of the Bartram botanic garden of Philadelphia in such hands that its proper protection and care should be assured for all time. It is a precious legacy to botanists and plant lovers, and of special historic interest. On March 7 the Philadelphia Select Council provided for its purchase, and will soon place it under the same management as the other city parks.

THE EXAMINATION of seventeen evergreen and deciduous trees [by L. A. Gulbe] gave the following general result: In spring the activity of the cambium begins in the twigs, passes thence into the stem, then into the thick and lastly into the smaller branches of the root, four to five weeks after its beginning in the twigs. Towards autumn its activity disappears in the same order, but the period of cessation covers two months. In the second half of October it has completely ceased in the roots.—*Bot. Centralblatt*, xxxviii, 487.

A BOTANICAL CONGRESS is to be held in Paris during next August, to which the Botanical Society of France invites foreign botanists. Those who expect to attend should send their names to M. P. Maury, Secretary of the Organizing Committee, 84 Rue de Grenelle, Paris, and obtain further information. Two subjects are especially proposed for consideration: Methods of studying geographical distribution of plants through coöperative action of scientific bodies, and Value of anatomical characters in classification. It is to be hoped that a number of American botanists may be present.

THE NEW French journal, *Revue Général de Botanique*, begins after a most vigorous and promising fashion. The articles which have appeared in the first four numbers are all of importance and by authors of the highest rank. Among the names are those of Rosenvinge, Guignard, Bonnier (the editor), Constantin, Leclerc du Sablon and Jumelle. The reviews of recent works in various departments are an extremely good feature, and very much more readable than the abstracts to which some journals devote themselves. The *Revue* is published by Paul Klincksieck, Rue des Ecoles, 52, Paris.

MRS. E. G. BRITTON begins in the April number of the *Bulletin* of the Torrey Botanical Club a series of papers with the title, Contributions to American Bryology. The first paper is an enumeration of the mosses collected in Kootenai county, Idaho, by Mr. Leiberg. One new species, Hypnum (Thamnium) Leibergii, is described, and also the fruit of Grimmia torquata. In February last, I also had the pleasure of discovering the fruit on specimens of this species sent me by Mr. Leiberg. In the material which came under my observation, the capsules were not infrequently slightly longer than stated by Mrs. Britton (0. 8—1. 2 x 0. 6mm. were my measurements) and a well-developed, persistent annulus, of three (rarely four) rows of cells was found. Mrs. Britton says, "Annulus none."—C. R. B.

AT THE MEETING of the Botanical Society of Munich, held on March 11, R. Hegler proposed the use of thallin sulphate as a new reagent for lignified tissues. All the previously used reagents, phloroglucin, and the salts of anilin, naphtalidin and toluidin are open to the objection that the reactions are transient and involve the use of an acid which is troublesome and requires considerable care. Thallin sulphate, however, obviates the use of an acid and the color it imparts to lignified walls, a deep orange yellow, is permanent. Its action is wholly upon vanillin. It should be used in a concentrated solution in dilute alcohol or in water. The solution should be protected from the light and is better prepared in small quantities as needed. Exposure to light causes the solution to become rose red, when it will impart this color to the cellulose and suberized walls, though the lignin reaction is not interfered with. The longer the action on sections the intenser the color.

SOME CONCLUSIONS of Belajeff as to the constitution of the antherozoids of ferns and equiseta, based upon researches in December, 1888, but just published[1] differ very materially from those of Guignard,[2] though the two observers seem to have seen about the same things. Belajeff says: "In all vascular cryptogams the body of the spermatozoid consists of a colorless band, in which a chromatin-filament or body is enclosed. The development shows that the achromatic band arises from the plasma, the chromatin body from the nucleus of the mother-cell." Guignard: "In the ferns it is again the nucleus alone that is transformed directly into a spiral band; the cilia arise from a peripheral layer, relatively thick, of hyaline protoplasm. * * * The morphological transformation of the nucleus is accompanied by internal modifications which render the spiral band homogeneous and equally chromatic, except in the posterior part where it is colored a little less by the reaction of the nuclein. The very delicate envelope of the body is not formed directly by the protoplasm."

M. GASTON BONNIER has, to our mind at least, completely settled the vexed question of the nature of lichens, by his recent experiments in the synthesis of these organisms. In the first part of the ninth volume of the *Annales* des sciences naturelles (botanique) he explains fully his methods of culture and the results attained.[3] The methods seem as rigid as possible. Stahl's researches in this direction, while of the utmost significance, were open to objection in that they did not exclude sources of possible error, because the cultures were exposed to ordinary air and the sowings were made on unsterilized media. Bonnier has avoided this source of error by carefully sterilizing all his media, culture flasks, implements, etc. Two methods of culture were used, flasks or tubes, and cells. In both cases arrangements were made for the renewal of the air either by the natural currents due to changes of temperature or by artificial means. In both cases germs were excluded by causing the air to pass through cotton plugs. Algæ of known species were collected (their purity demonstrated by microscopic examination) and sowed on pieces of sterilized bark, rocks, etc. Then spores of lichens were sown on the same substratum. Except in one instance, fructifications were obtained within two years. The following is a list of the species grown in this way. In appearance and structure they were like the wild forms: With Protococcus, Physcia parietina, P. stellaris, Parmelia Acetabulum; with Pleurococcus, Lecanora sophodes, L. subfusca, L. coilocarpa, L. cæsio-rufa; with Trentepohlia, Opegrapha vulgata, Graphis elegans, ?Verrucaria muralis.

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[1] Berichte d. deutsch. bot. Gesells. vii. 122.

[2] See this journal, ante, p. 137, and Revue gén. de Bot. i. 71.

[3] Brief reference was made to some of Bonnier's results in this journal, xii. 202. His experiments were begun in 1882 and completed last year.

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Notes on cultures of Gymnosporangium made in 1887 and 1888.

ROLAND THAXTER.

In a paper "On certain cultures of Gymnosporangium, with Notes on their Rœsteliæ," published in the proceedings of the American Academy of Arts and Sciences (vol. xxii, p. 259), I gave the results of experiments undertaken in the spring of 1886, at the suggestion of Prof. Farlow, with a view to determine, if possible, the connection existing between the various species of Gymnosporangium and Rœstelia found in the vicinity of Boston; and since the publication of the paper referred to, similar cultures have been continued yearly, the results of which are given in the present article. In order, however, to make myself intelligible, it may be expedient to summarize my previous results, the more so since my later cultures necessitate some modification of the views then expressed concerning one at least of the Rœsteliæ obtained.

Having in the cultures of 1886 succeeded in obtaining æcidia from five of the seven species of Gymnosporangium common in New England, it became necessary to determine with some accuracy to which of the numerous forms of Rœstelia these æcidia severally belonged; and to this end a large number of specimens were examined, including numerous examples from European exsiccati, which the kindness of Prof. Farlow placed at my disposal. As a result of this examination, it became evident that the opinions generally accepted in this country concerning the identities existing between the American and European forms were erroneous in several important particulars.

RŒSTELIA PENICILLATA, for example, a species incorrectly referred to R. lacerata, by certain authors, but very properly retained as distinct by Winter (Pilze, p. 266), was found, after an examination of several authentic European specimens, to be a well-marked form quite different from any known American species. R. penicillata, therefore, must be definitely excluded from the list of American forms unless it has been wholly overlooked; a supposition which seems

quite improbable. Turning to the American forms previously included under the name "penicillata" it was found that they included two well-marked species, namely, R. pyrata and R. lacerata.

Rœstelia pyrata, the Æcidium pyratum of Schweinitz, which was obtained from sowings of G. macropus upon Pyrus Malus, was found to be a peculiarly American form, readily separable from any known European species and not to be confounded with any other American species: from all of which it is readily distinguished by its habit alone, as well as by its microscopic characters. It is distributed in Ellis' N. A. Fungi No. 1086 a, b, and d (*not* c), under the name "penicillata," and also from America in Thuemen's Myc. Un. No. 732 under the name "lacerata." It is very common on Pyrus malus and often destructive, but grows most luxuriantly on P. coronaria; and may be readily distinguished from the only other Rœstelia common upon Pyrus malus, by its *revolute* peridial lacerations. I make this statement in detail from the fact that I have subsequently been quoted as considering R. pyrata a form of R. penicillata, whereas my expressed opinion was exactly the contrary of this statement; and also for the reason that I notice the name "penicillata" still retained by certain American writers when referring to R. pyrata, which is a manifest error.

The second form above referred to, which has, in this country, been wrongly considered a form of R. penicillata, is beyond question the true

Rœstelia lacerata.—This was obtained from sowings of G. clavariæforme on Cratægus. In its general habit it bears a superficial resemblance to R. pyrata, but the peridial lacerations are only slightly divergent, not revolute; while it is also readily separable microscopically. In its most typical form it attacks the fruit and tender shoots of Cratægus, and more especially of Amelanchier; but it also occurs upon the leaves of both these plants, and has recently been found by Prof. Farlow on the fruit of Pyrus arbutifolia, a hitherto unrecorded host. The species is distributed in Ellis' N. A. F. No. 1086 c, in my copy, (*not* a, b or d), under the name "penicillata," and also under the names "*carpophila* Bagnis" (Myc.Un. 1326) and "lacerata" in various European exsiccati. "Rœstelia lacerata," however, as it is commonly understood in this country, is quite another thing. In my previous paper I spoke of the forms referred to R. lacerata for the sake of convenience as lacerata *x*, *y* and *z*: "lacerata *x*" being used

for the true R. lacerata as above distinguished; "lacerata *y*" for the form common on Cratægus, usually known in this country as the typical R. lacerata, and distributed in Ellis' N. A. F. No. 1085 under this name, the specimens labelled "a" on Cratægus coccinea being the most typical; while "lacerata *z*" was used to designate a small form apparently not distributed, but very common (in New England, at least) upon leaves of Pyrus Malus, especially on wild stock. These two forms ("lacerata *y*" and "*z*") I shall have occasion to refer to presently in connection with G. globosum. It is, therefore, sufficient to say that I then suggested their identity with

RŒSTELIA CORNUTA.—To this species I was constrained, I think erroneously, to refer the æcidium which followed the infection of Amelanchier with what I then considered the American form of G. conicum, namely, the common "birds'-nest" Gymnosporangium figured in Farlow's "Gymnosporangia of the U. S.," plate II, fig. 22, under the name G. clavipes, and distributed also as clavipes in Ellis' N. A. F. No. 1084 b (*not* a). I say constrained, since the Rœstelia was referable to no other described species, and it seemed that the differences between the culture and our supposed forms of R. cornuta might have been accidental.

RŒSTELIA BOTRYAPITES, a form not to be confounded with any other American species followed sowings of G. biseptatum on Amelanchier.

RŒSTELIA AURANTIACA which followed sowings of the true G. clavipes on Amelanchier stems is also too well marked to need further comment. It may be mentioned here, however, that although Cratægus, Amelanchier, Pyrus Malus and Cydonia are the only recorded hosts of this species, it has been observed by Prof. Farlow on the fruit of Pyrus arbutifolia in Massachusetts, and Mr. Miyabe has kindly sent me a specimen collected by him on the same host at Grand Menan Island.

The experiments with G. Ellisii were not satisfactory, while G. globosum produced nothing beyond its usual luxuriant and brightly colored spermogonia on Cratægus; spermogonia also appearing on Sorbus and Amelanchier; but in no case producing æcidia, the leaves having withered and fallen off about two months after their infection.

The above contains in general the results of my first cultures. Turning now to those subsequently made the results were as follows. It should be stated at the outset that, like the first set of cultures, those subsequently made were conducted

under conditions as rigid as they could practically be made, a circumstance upon which, I think, too great stress cannot be laid in connection with any experimental work of this nature. In all cases the Gymnosporangia were gathered before they had had an opportunity of becoming mixed; in fact before they were fully mature, and the hosts for infection were in all cases potted plants, started early in the house or greenhouse, and infected in different rooms or buildings, being subsequently kept separate till all danger of accidental mixture was past. It is hardly necessary to point out the superiority of this method over cultures made out of doors, in which the possibility of error cannot be eliminated; but by far the most crucial test in such cases is gained by forcing the fungus as well as its host so as to make the infection a month or more before it would naturally occur out of doors, as was done, for example, in the second culture of G. globosum given below. In this way the sources of error are reduced to zero if, as in this case, only one species of Gymnosporangium is used. As in my previous cultures, I have found it more convenieut to place the spore masses directly upon the sprinkled leaves, as soon as the sporidia begin to form, and to keep the plants covered with bell glasses or wet paper for one or two days, carefully removing the jelly as soon as these were taken off.

CULTURES OF 1887.

G. MACROPUS.

March 1. Sporidia sown on
2 *Pyrus Malus*,
both host and fungus having been forced in a greenhouse where the subsequent development was watched.

March 10. Spermogonia appeared abundantly on both plants, from which one recovered while the other

May 1, produced æcidia of *Rœstelia pyrata*.

G. CLAVARIÆFORME.

April 24, sporidia sown on
2 *Amelanchier Canadensis*.

April 27, sporidia sown on
1 *Amelanchier Canadensis*.
1 *Cratægus coccinea*.

May 1. Spermogonia appeared on the two first Amelanchiers, which were much distorted.

May 5. Spermogonia on the second Amelanchier. No result with the *Cratægus*.

May 6. The two first Amelanchiers much swollen and distorted, æcidia already beginning to appear.

May 12. Æcidia of *Rœstelia lacerata* ("*lacerata x*") developed luxuriantly on all the Amelanchiers. No result with *Cratægus.*

"G. CONICUM."

April 28. Sporidia sown on
2 *Cratægus coccinea.*

May 4. Sporidia sown on
2 *Pyrus Malus.*
2 *Cratægus coccinea.*
1 *Amelanchier Canadensis.*
2 *Sorbus.*

May 8. Leaves of one *P. Malus* much discolored, but no spermogonia developed. Sporidia sown on
1 *Amelanchier Canadensis.*

May 12. Leaves and stems of both Amelanchiers much distorted.

May 14. Spermogonia on both Amelanchiers. No results with the other plants.

May 24. Æcidia began to show on the Amelanchiers, which developed into a *Rœstelia* identical with that obtained from the same *Gymnosporangium* in 1886.

G. GLOBOSUM.

During the second week in May (the exact date not recorded) sporidia were sown on large potted plants as follows:
2 *Cydonia vulgaris.*
2 *Pyrus Americana.*
3 *Cratægus coccinea.*
2 (small) *Pyrus Malus.*

Spermogonia appeared abundantly on *all* these hosts in ten days, especially on the *Cratægus.* The plants were watched in the house until June 7, when they were set out in the yard of the house in Boston where the culture was made, and left during the summer. On examination early in September "*lacerata y*" was found developed abundantly on the *Cratægus,* and "*lacerata z*" on two leaves of apples, the leaves having fallen from both the *Cydonia* and *Sorbus.*

CULTURES OF 1888.

G. GLOBOSUM.

March 17. Sporidia sown on
1 *Pyrus Malus,*
3 *Cratægus,*
all having been forced in the greenhouse at the botanic garden in Cambridge.

March 28. Spermogonia appeared abundantly on all the infected plants. These were then watched carefully for three months, at the expiration of which,

June 19. Æcidia began to appear on the leaves of the *Cratægus*, while the apple showed swellings beneath the spots of spermogonia. These swellings began slowly to produce æcidia, having, as far as could be judged, the characters of "*lacerata z*," but

July 7. The leaves suddenly turned yellow and fell off, while at this date "*lacerata y*" was abundantly developed on the *Cratægus*.

"G. CONICUM."

Two plants of *Amelanchier* were sown with sporidia of the "birds-nest" *Gymnosporangium* for class illustration on May 12, spermogonia appearing in about a week (the exact date not noted), and during the second week in June a *Rœstelia*, similar in all respects to that obtained in the previous years, was well developed upon the stems and leaves.

The cultures of 1887–88, then, agree with the results of the previous year in all respects so far as the æcidia obtained from the corresponding Gymnosporangia is concerned, and supplement them by the addition of the æcidial form of G. globosum, the relation of which to any æcidial form has heretofore been a most perplexing question. The cultures establishing this relationship which were made in 1888 were, it will be noticed, conducted with the greatest care. The fungus and its host were forced in a greenhouse, and the infection made more than six weeks before it would naturally have occurred out of doors, and the plants were constantly examined during the whole period from infection to the production of æcidia. No other species of Gymnosporangium was brought into the greenhouse, and when the season for the natural development of the fungus out of doors had arrived, the possibility of infection from without was past. There is, therefore, no shade of doubt connected with the experiment, the result of which is, moreover, supported by the results obtained in the more careless cultures of the previous year. Although in the present instance the culture on apple was not carried as far as could have been desired, I think it may be safely assumed that both "*lacerata y*" and "*lacerata z*" are æcidia of G. globosum. This conclusion is somewhat of a surprise, since G. globosum has been considered a very near ally of the European G. fuscum, of which it was originally described as a variety. The æcidium of G. fuscum, on the other hand, is stated definitely by Mr. Plowright to be R. cancellata; a conclusion in harmony with the

views of previous experimenters. But "*lacerata y*" and "*z*" have not the slightest resemblance to R. cancellata. On the contrary, as I pointed out in my previous paper, the Rœstelia which I called "*lacerata y*" is closely allied to R. cornuta, which has been referred by Mr. Plowright, also in concurrence with previous opinion, to G. conicum.

Turning for a moment to our birds'-nest Gymnosporangium, the question of identities is still further confused by my cultures of this species, made on three successive years with identical results. The Rœstelia obtained, as I have mentioned above, was referred to R. cornuta, there being no other alternative among described American Rœstelias. It seemed not unlikely that the differences between the culture and R. cornuta might have been accidental; but the subsequent cultures render this supposition very improbable. In all cases we have the same rapidly-developing Rœstelia resembling R. lacerata in its mode of growth. In nature the form has probably been confused with R. lacerata, with which it must occur simultaneously on Amelanchier. It should be noted that upon Sorbus (the natural host of R. cornuta) the most careful sowings of our "birds'-nest" Gymnosporangium have given no result whatever; and also that, although our species is certainly known to occur only on Juniperus Virginiana, the European G. conicum is found only on J. communis. Further careful cultures and observation, together with a more extended examination of European specimens than I have been able to make, will, of course, be necessary to confirm this supposition; but I am decidedly of opinion that our "birds'-nest" species is a distinctly American form as yet unnamed.

Unfortunately, however, we still have to account for what appears to be the typical R. cornuta on Sorbus collected at Eastport by Prof. Farlow, and subsequently at Grand Menan Island by Mr. Miyabe, and in the White Mountains by Prof. Farlow and myself. In addition also to these, we have unaccounted for a not very common form on Amelanchier and one on Pyrus arbutifolia found at Kittery, Maine—both of which do not appear to differ essentially from R. cornuta. Whether all these forms may not be referable to "lacerata *y*," and consequently to G. globosum, I do not feel at present prepared to say; but the only remaining alternative would seem to be that the true G. conicum occurs in this country on its proper host (J. communis), but has hitherto been overlooked.

Returning for a moment to the cultures of G. clavariæforme, it is of interest to note that one of the plants infected in 1887, on which the Rœstelia had developed with great luxuriance, was left out of doors over night during a rain, in order to observe the effect thus produced upon its general habit. Before this exposure the peridia had remained unbroken, as is usually the case with cultures carried on indoors; but a single night in the rain was sufficient to induce the typical "penicillate" habit peculiar to the true R. lacerata. This circumstance removes any doubts in connection with my determination of this species which may have rested on the failure of my previous culture to assume a lacerate habit. It should be mentioned here that in the Bulletin of the Iowa Agricultural College for 1887, Prof. Halsted describes a culture of G. clavariæforme made by him out of doors upon Amelanchier with material sent from the east, which resulted in the production of a Rœstelia which he referred to R. botryapites, thus throwing doubt upon my results both with G. biseptatum and G. clavariæforme. Prof. Farlow has kindly allowed me to state in this connection that the Rœstelia communicated to him by Prof. Halsted as resulting from this culture is certainly *not* R. botryapites. That my first result was correct is sufficiently shown by my subsequent cultures, as well as by the conclusions of European experimenters. It is, moreover, quite improbable that a Gymnosporangium, also well known in Europe, should produce a Rœstelia which occurs only in America.

During the summer of 1887 I had some opportunity of observing the Rœstelias occurring in the mountains of North Carolina, concerning which a note may be of interest. At Cullowhee, in the southwest portion of the state, and elsewhere in the same region, cedars (J. Virginiana) were not indigenous, but had been introduced in small numbers, and were in most cases loaded with "cedar apples" to a degree seldom if ever met with in the North, and in one case, near the town of Sylva, two large trees seemed to have been literally killed by them, while in several other cases their detrimental effect was apparent. The season of their maturity was passed at the time (June), but the species were readily recognized as G. macropus and G. globosum, both attaining a remarkable size. I noticed, however, no conspicuous distortions referable to our "birds'-nest" species. Of Rœstelias I found three forms. One on Cratægus Crusgalli, collected at Sylva, fully developed on June 13, I have been unable

satisfactorily to identify. At Cullowhee two or three small cedars badly infested by G. macropus and G. globosum, served to infect the region within a distance of a mile or more, and during June and July the Cratægus and Pyrus coronaria, common in the vicinity, were covered with spermogonia. On leaving this locality (July 18) the spots on Pyrus were developing a luxuriant growth of Rœstelia pyrata, while those on Cratægus showed no signs of æcidia. This Cratægus form was, however, collected and forwarded to me during the following August by my friend Mr. T. B. Cox, and proved to be "lacerata *y*"; in other words, the æcidium of G. globosum, as was to be expected. Spermogonia were also seen on Amelanchier at the falls of the Tuckaseegee river, between Cullowhee and Highlands; but no æcidia were procurable. The virulence of R. pyrata on certain varieties of cultivated apples in this region was remarkable. I noticed several instances on the road between Sylva and Asheville, where cedars had been planted near small orchards, some of the trees in which were so infested by R. pyrata that the bright color was striking at even a considerable distance, while side by side with these were individual trees which showed no sign of the fungus.

In the mountains of East Tennessee, in other respects a mycologist's paradise, no signs of any Rœstelias were to be found, although shortly after entering the mountains, I saw abundant spermogonia on Amelanchier from the car window.

SUMMARY OF CONCLUSIONS.

Rœstelia penicillata is not found in this country so far as is known. The American forms thus named hitherto, include two distinct species, namely, R. pyrata, which is the æcidium of Gymnosporangium macropus and R. lacerata, which is the æcidium of G. clavariæforme.

Rœstelia lacerata, as it is generally known in collections, and as it is distributed in Ellis' N. A. F., No. 1085, is incorrectly named and is the æcidium of G. globosum, to which should also be referred the smaller form common on Pyrus malus.

R. botryapites is the æcidium of G. biseptatum.

R. aurantiaca is the æcidium of G. clavipes.

R. cornuta is *not* the æcidium of the "birds'-nest" Gymnosporangium previously referred to G. conicum and distributed as G. clavipes in Ellis' N. A. F., No. 1084 (b). The "birds'-nest" form with its Rœstelia as obtained by cultures is therefore probably unnamed, unless G. conicum is erro-

neously connected with R. cornuta by European experimenters. R. cornuta as it occurs in this country on Sorbus, Amelanchier and P. arbutifolia either represents variations in the æcidia of G. globosum or results from the true G. conicum which has been hitherto overlooked.

NOTE.—Since the above was in press the writer has found the Rœstelia of the "bird's nest" Gymnosporangium growing simultaneously with R. lacerata very abundantly on Amelanchier, thus confirming the view above expressed. Further details will be given in a subsequent paper, together with notes on cultures made during the present year.

New Haven, Conn.

Flowers and Insects. II.

CHARLES ROBERTSON.[1]

Viola pubescens Ait. (fig. 1).—Müller regards the yellow violets as nearest the primitive type. This is yellow with dark nectar-lines. The petaline spur is little more than a gibbosity. The nectar-secreting processes of the lower stamens are very short, being much wider than long. The summit of the peduncle and the flower axis are strongly curved so as to throw the spur well backwards, giving the flower a characteristic appearance, and this serves to limit the insect visits much more than the mere length of the spur. The tips of the anthers and the style are closely approximated to the spurred petal and obstruct the entrance, so that insects unaccustomed to the flower are effectually baffled in their attempts to reach the nectar. The lateral petals are bearded.

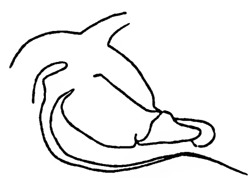

FIGURE 1.

The stigma is nearer the anthers than in V. palmata and V. striata, and self-fertilization in case of insect-absence is more probable.

A proboscis 3 mm. long can secure the nectar, if the bee forces its head in as far as the anthers. Bees receive the pollen mainly on the under side of the head, and work it back into their scopæ, when collecting it. After visiting several flowers, Osmia settles upon a fallen leaf and applies the pollen to her ventral scopa, and then returns to the flowers.

After watching the flowers on six days, between April 16 and 30, I obtained only six visitors; but on April 20, 1889, in two hours watching I added twelve new names.

[1]On the fertilization of the genus see Müller: Fertilization of Flowers, 117-121 and 634.

Hymenoptera—*Apidæ:* (1) Anthophora ursina Cress. ♀, s., once; (2) Synhalonia honesta Cress. ♀, s., once; (3) Ceratina dupla Say ♀, s., once; (4) Osmia albiventris Cress. ♂ ♀ (=O. rustica Cress. ♂), s. and c. p., very ab.; (5) O. atriventris Cress. ♀, s. and c. p., ab.; (6) Nomada bisignata Say ♀, once. *Andrenidæ:* (7) Andrena sp. ♀, s. and c. p., once; (8) Augochlora pura Say ♀, s. and c. p., ab.; (9) Halictus coriaceus Sm. ♀ s.; (10) H. fasciatus Nyl? ♀, s; (11) H. pilosus Sm. ♀, s. and c. p.; (12) H. connexus Cress. ♀, s.; (13) H. stultus Cress. ♀, s. and c. p.

Diptera—*Bombylidæ:* (14) Bombylius fratellus Wied., s., ab. *Tachinidæ:* (15) Gonia frontosa Say, s., once.

Lepidoptera—*Rhopalocera:* (16) Colias philodice Godt.; (17) Nisoniades juvenalis F.; (18) N. martialis Scud. All sucked in a reversed position, except nos. 1, 14 and 16–18. Paragus tibialis, Melanostoma obscurum and Mesograpta marginata (Syrphidæ) eat stray pollen.

Viola palmata L. var. *cucullata* Gray (fig. 2).—This is our common blue violet. The lateral petals are bearded. The stigma touches the bee in advance of the anthers, and cross-fertilization is the natural result of insect visits. The staminal processes measure 3mm. and the spur about 4mm. The nectar is more deeply concealed than in V. pubescens, and, as a consequence, the list shows more long tongues.

FIGURE 2.

Hymenoptera—*Apidæ:* (1) Apis mellifica L. ☿, once; (2) Bombus separatus Cress. ♀; (3) B. pennsylvanicus De G. ♀; (4) Synhalonia speciosa Cress. ♂; (5) S. honesta Cress. ♀; (6) Ceratina dupla Say ♀, all sucking; (7) Osmia albiventris Cress. ♂ ♀, s. and c. p., ab.; (8) O. atriventris Cress ♀, s. and c. p., ab.; (9) Nomada vincta Say ♀, s. *Andrenidæ:* (10) Andrena sp. ♂ ♀, s. and c. p., ab.; (11) Halictus sp. ♀, s.; (12) H. fasciatus Nyl? ♀, s.

Diptera—*Bombylidæ:* (13) Bombylius fratellus Wied., s.

Lepidoptera—*Rhopalocera:* (14) Pyrameis huntera F.; (15) Colias philodice Godt.; (16) Pieris rapæ L.; (17) Nisoniades juvenalis F.; (18) N. martialis Scud. All sucked head downwards except nos. 6, 11 and 13; nos. 14–18 sometimes upright, sometimes reversing. Observed on nine days, between April 9 and 29.

Viola striata Ait. (fig. 3).—The flower is yellowish white, a few purplish lines on the lower petal forming nectar-guides. The lateral petals are bearded. The stigma is far in advance of the anthers, so that self-pollination is prevented. The spur is considerably longer than in V. palmata. On three days, between April 16 and May 4, I observed only:

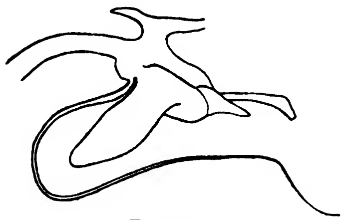

FIGURE 3.

Hymenoptera—*Apidæ:* (1) Synhalonia honesta Cress. ♂, s.; (2) Osmia albiventris Cress. ♀, s. and c. p., ab.; (3) O. atriventris Cress. ♀, s.; (4) O. montana Cress. ♀, s. and c. p. *Andrenidæ:* (5) Andrena sp. ♀, s.; (6) Halictus coriaceus Sm. ♀, s. and c. p.

Diptera—*Bombylidæ;* (7) Bombylius fratellus Wied. s.

Lepidoptera—*Rhopalocera:* (8) Colias philodice Godt.—all reversing except nos. 1, 7 and 8.

Viola pedata L. var. *bicolor* Gray (fig. 4).—The flowers are larger than in any of the preceding species. The two upper petals are of a deep purple, the others blue, the handsome flowers bearing a resemblance to the pansy. The lateral petals are not bearded. The lower petal is deeply grooved and is produced behind into a curved spur from 4 to 8 mm. long. The strong style and the anthers project considerably and oppose the way to the nectar, so that the extent of concealment of the nectar is determined by the distance from the tip of the style to the tip of the spur—a distance of from 12 to 16 mm. The staminal spurs are about 4 mm. long and are very slender. The spur of the lower petal is slender and strongly compressed so as to narrow its cavity. As might be expected, the visitors are the longest-tongued bees, though butterflies often occur. The pollen is shed on the base of the proboscis of the insect.

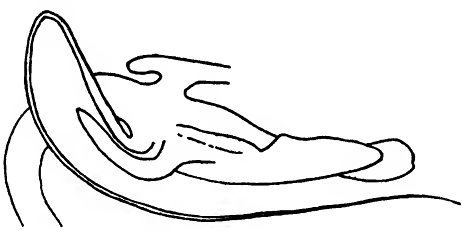

FIGURE 4.

Hymenoptera—*Apidæ:* (1) Bombus virginicus Oliv. ♀ (14)[2]; (2) B. separatus Cress. ♀ (11–13); (3) B. pennsyl-

[2]Numbers in parenthesis after the name of the bee indicate the length of the proboscis in mm.

vanicus DeG. ♀ (16–17), ab.; (4) Anthophora ursina Cress. ♀ (18), s. & c. p., ab.; (5) Synhalonia speciosa Cress ♂ ♀ (13–15), all sucking in an upright position.

Lepidoptera—*Rhopalocera:* (6) Pyrameis cardui L., once, reversing; (7) Colias philodice Godt., sometimes reversing; (8) Nisoniades icelus Lintn., ab.; (9) N. juvenalis F., both always reversing. *Noctuidæ:* (10) Plusia simplex Guen., once, not reversing. On four days, between April 28 and May 3.

Eristalis latifrons eats stray pollen which falls upon lower petal.

Viola lanceolata L.—At Orlando, Fla., Feb. 17, I found it visited by Hymenoptera—*Andrenidæ:* (1) Halictus capitosus Sm. ♀, s. Lepidoptera—*Rhopalocera:* (2) Phyciodes tharos Dru.; (3) Pamphila sp.

General notes on the foregoing violets.—In a paper on the cause of floral irregularity,[3] Viola was mentioned as an exception to the rule that irregular polypetalous flowers have the nectary on the upper side. I think the spur was developed in a way analogous to the galea of Aconitum, *i. e.* on the upper side of the flower, and that it has changed to the lower side as a result of inversion of the flower. The weight of the spur itself may have had something to do with turning the flower upside down. Not only would the flower be expected to have been originally sternotribe from my theory, but it is still properly so, for in most cases it is so formed that bees are required to turn upside down to reach the nectar. Fig. XI of the title page of Sprengel's "Entdeckte Geheimniss" shows a flower of V. odorata with a hive-bee sucking in a reversed position. The spur seems to have become so closely fitted to the bee that after inversion the bee was forced to turn head downwards in order to extract the sweets.

On the part of the flower, the resupinate position seems to be advantageous in enabling it to sift the pollen down upon the insect, instead of exposing it to pollen-eating intruders. Under V. tricolor, Müller says: "The anthers, which together form a cone, shed their pollen into this groove (*i. e.* ot the lower petal), either of themselves or when the pistil is shaken by the insertion of the bee's proboscis." It seems to me that the action to which the mechanism is adapted to give

[3] Bot. Gaz., XIII., 207.

rise, and the only action which will insure that the pollen shall be applied to the same side of the proboscis which touches the stigma, is that the pollen discharge shall be effected by the bee itself.

On the part of the visitors, the inversion seems particularly favorable to bees of the genus Osmia, and I am inclined to consider the flowers of V. pubescens, palmata and striata as specially adapted to them, in spite of the presence of other visitors. Now, these bees have their pollen-collecting hairs situated on the ventral surface of the abdomen, so that the position which they must take to suck is the one which enables them to receive the pollen and apply it to their scopæ most conveniently. For this reason, species of Osmia are the most abundant and most useful visitors. Indeed, for the species referred to, I am convinced that Osmia albiventris and atriventris are of more importance than all of the other visitors put together. Müller mentions bees of this genus as visitors of V. odorata, canina and tricolor, var. arvensis.

Delpino (178)[4] has discovered that the beards on the lateral petals are intended for the bee to cling to when it turns head downwards. He rightly regards the bees which reverse as legitimate visitors, and considers the action of Anthophora pilipes on V. tricolor as illegitimate, since it inserts its proboscis without turning. Really, the proper visitors are bees which are small enough to use the beard as a support; so that the humble-bees and butterflies may properly be classed as intruders, even when they reverse. For the proper visitors of the bearded violets we must look to small bees, among which the Osmias are most important.

Remembering that the bearded violets are sternotribe, it is interesting to observe that they become nototribe with respect to all visitors, like Anthophora and Bombylius, which fail to reverse, and this enables us to understand how a properly nototribe violet might be produced. V. pedata is a violet of this sort, being visited mainly by long-tongued bees, which light upon the spurred petal and remain upright. The lateral petals have lost their beards, since they are no longer of use to the bees. The flower still retains the upward curvature of the spur as an ancestral characer. If the spur had been developed with reference to visitors acting like most of those now seeking it, I think it would curve down rather

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[4] Numbers in parenthesis after an author's name are the numbers of titles in Thompson's Bibliography. See Müller: Fertilization of Flowers, pp. 599-634.

than up. The effect of the upward curvature of the spur is well illustrated in the behavior of Nisoniades, which invariably turn head downwards.

It has often occurred to me that Bombylius could suck the bearded violets more easily than the insects which reverse, and that under certain conditions it might take possession of them, as Anthophora and Bombus have done in the case of V. pedata. In this connection, it is interesting to refer to Müller's observations on V. calcarata. He saw Macroglòssa stellatarum visit 194 flowers of this violet in 6¾ minutes. So rapid a visitor might easily take possession of any flower which suits its fancy. V. calcarata appears to have become completely adjusted to a new set of conditions, for its spur, as shown in Müller's figures, turns downward, and not upwards as in V. pedata.

Claytonia Virginica L.—The proterandry of this flower was first recorded by Bessey (87). He concludes that the adaptations are to favor cross-fertilization and to prevent self-fertilization, and my observations confirm his view. On the other hand, Meehan, in a paper on "The 'Sleep of Plants' as an Agent in Self-fertilization" (485), regards it as commonly self-fertilized by closing of the petals. This mode of self-fertilization was discussed by Ch. Fermond[5] in 1859, but C. Virginica is a very poor example of it. Indeed, it is most erroneous to suppose that it is commonly self-fertilized in this way, for it is one of the most marked cases of proterandry in native plants.

On the first day the stamens stand in the center of the flower and the anthers discharge their pollen, but the lobes of the stigma remain closed. The flower is visited very abundantly by insects which suck up the honey and which eat or collect the pollen, so that by the time the flower closes the pollen is commonly all removed. On the second day the stamens are bent over, holding the empty anther against the petals. The stigma lobes are now separated, and the flower is in the second or female stage. If self-fertilization by closing of the flower occurs, it is after the anthers have been exposed to insects for two days and the stigma for one, but many flowers which I marked exposed their stigmas again on the third day, showing that fertilization of any kind had failed on the day before. The flowers are therefore male on the first day and female on the second and sometimes on the third.

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[5] See Just's Bot. Jahresbericht, IV, 939.

Moreover, Meehan states that he did not see the flowers visited by insects—an observation easy to make on any flower. The plants grow in large patches and are very attractive to a great variety of insects. The nectar is not deep seated, so that rather short tongues can reach it. On 26 days, between April 8 and May 11, the following visitors were observed:

Hymenoptera—*Apidæ:* (1) Apis mellifica L. ☿, s. and c. p.; (2) Bombus virginicus Oliv. ♀; (3) B. vagans Sm. ♀; (4) B. pennsylvanicus DeG. ♀; (5) Synhalonia honesta Cress. ♂; (6) S. speciosa Cress. ♀; (7) Ceratina dupla Say ♂; (8) Osmia lignaria Say ♂ ♀; (9) O. albiventris Cress. ♂ ♀; (10) Nomada bisignata Say ♀; (11) N. luteola St. Farg. ♂ ♀, all only sucking, except no. 1. *Andrenidæ:* (12–20) Andrena spp., s. and c. p., ab.; (21) Agapostemon radiatus Say ♀, s and c. p.; (22) Augochlora pura Say ♀, s.; (23) A. lucidula Sm. ♀, s.; (24) Halictus sp. ♀, s. and c. p.; (25) H. coriaceus Sm. ♀, do.; (26) H. fasciatus Nyl? ♀, do.; (27) H. pilosus Sm. ♀, do,; (28) H. connexus Cress. ♀, do.; (29) Colletes inæqualis Say ♂ ♀, s.

Diptera—*Stratiomyidæ:* (30) Sargus viridis Say. *Bombylidæ:* (31) Bombylius fratellus Wied., s. *Conopidæ:* (32) Myopa vesiculosa Say, s. *Empidæ:* (33–35) Empis spp. s. *Syrphidæ:* (36) Melanostoma obscurum Say; (37) Syrphus arcuatus Fall.; (38) S. ribesii F.; (39) S. americanus Wied.; (40) Allograpta obliqua Say; (41) Mesograpta marginata Say; (42) M. geminata Say; (43) Sphærophoria cylindrica Say; (44) Eristalis dimidiatus Wied.; (45) E. latifrons Lu.; (46) Helophilus similis Macq.; (47) Syritta pipiens L.—all sucking and feeding on pollen. *Tachinidæ:* (48) Gonia frontosa Say, s. *Sarcophagidæ:* (49) sp., s.; (50, 51) Sarcophaga spp., s. *Muscidiæ:* (52) Lucilia cæsar L.; (53) L. cornicina Mgn.; (54) L. ruficeps Mgn., all s. *Anthomyidæ:* (55–57) spp., s. *Cordyluridæ:* (58) Scatophaga squalida Mgn., s. *Sepsidæ:* (59) Sepsis sp. *Drosophilidæ:* (60) Drosophila sp.

Lepidoptera—*Rhopalocera:* (61) Phyciodes tharos Dur.; (62) Pyrameis atalanta L.; (63) Lycæna comyntas Godt.; (64) Papilio ajax L.; (65) Pieris protodice Bd.-Lec.; (66) P. rapæ L.; (67) Colias philodice Godt.; (68) Nisoniades icelus Lintn.; (69) N. juvenalis F.—all s.

Coleoptera—*Chrysomelidæ:* (70) Megilla maculata DeG. *Curculionidæ:* (71) Centrinus sp.

Carlinville, Ill.

BRIEFER ARTICLES.

Curious case of variation in Calla.—A strange and rather remarkable case of variation in the flower structure of this familiar plant recently came to my notice through the kindness of a local florist, who called my attention to it, and upon my observation of its rarity gave it to me for such use as I chose to make of it.

It presented a well marked example of "double flower" in every essential respect. The flower structure of the Calla is so well known that no special description is necessary. The plant itself was perfectly normal to all appearance, save the flower, including care and environment. The stalk upon which this particular flower was borne was not appreciably larger than ordinary. In short, there was nothing to indicate the possibility of the monstrosity prior to its appearance. Yet there it was, a perfectly "double calla," in a very literal sense; for the "double" feature extended to spadix as well as spathe. The only appreciable difference in the parts was in size. The outer and normal flower was very large and fine; the inner was pure in color and texture, but was less than half the ordinary size. This difference was likewise true as to the spadixes, which varied in about the same way, save that they were partially fused together, while the former were wholly distinct.

Such, in brief, is a general statement of the facts. Monstrosity is not an unusual thing in nature, especially under the influence of domestication; but a glance at the literature of the subject, though limited, seems to indicate that this is a rather rare case. According to Professor Gray, indeed most botanists, flowers are to be considered as the morphological counterparts of leaves modified in such way as to conserve the ends of reproduction. The calla has been considered as a striking example of such modification, the transition being so gradual as to be appreciable by even the ordinary observer, there being no floral envelopes save the single, large, modified leaf, in which the original shape is but little changed.

When variations of these envelopes occur they usually show a disposition to revert to primitive conditions, "retrograde metamorphosis," or to go on to multiply after the forms of foliage, "prolification." There are many examples of these among flowering plants; but neither seems to cover the case under consideration, unless it be that of prolification in disguise. Again quoting Prof. Gray: "In the application of morphological ideas to the elucidation of the flower, nothing should be assumed in regard to it which has not its counterpart and exemplar in the leaves and axis of vegetation." (Structural Botany, p. 174, vol. I—sixth edition.) Does the case under consideration not force us to regard some flower structures as at least partial exceptions to the general laws of variation? Unless it may be regarded as a case of prolification in disguise, which seems open to doubt, then there seems really no alternative except to

consider it an illustration of the theory of "saltation," proposed to cover cases of a similar sort in zoölogy.

Not being a specialist in botany, I submit the case, and have reluctantly suggested the above reflections in the most tentative way. If they may awake an interest on the part of those more capable of opinions, this notice will not have been in vain.—C. W. HARGITT, *Miami University Oxford, Ohio.*

Poisonous plants and the symptoms they produce.—When horses, cattle or sheep here die from unknown causes, which have produced more or less marked cerebral disturbance within a few days or hours before dissolution, accompanied by one or more minor symptoms, they are said to have been "locoed," that is, poisoned by some usually mysterious unknown plant. The general symptoms are here given in the order they usually appear:

The animal wanders alone, has unnaturally bright eyes and slight frothing at the mouth, or even extreme salivation occurs and the creature goes about with a stream of clear saliva trickling from its chin to the ground, or else the lips are dry, a little swollen and the whole mouth very hot. The appetite becomes noticeably impaired; large quantities of offensive gas are belched forth, frequently accompanied by a greenish froth mixed with finely chewed food. The brain now becomes plainly affected—control of limbs partially or wholly lost—sometimes muscles of one side of the neck are contracted in a pitiable manner. In a few days, hours or minutes, as the case may be, after proper limb-control is lost, the staggering animal refuses to eat or drink at all, becomes stupid, reels and falls, seldom rising again. Stupor increases, eyes become dull and staring, perfect torpor comes on. Limbs and neck may become quite rigid and extended, or else in natural position and easily moved by the hand. Abdomen usually swells to enormous size. Victim may lie in this condition a week or death may ensue in a few hours; there is rarely any struggle at that time.

Post mortem examination reveals several interesting features. The intestines with their surrounding fat are already green, although the creature may have only just died. The arteries and smaller vessels in the limbs are gorged with thick, black blood. The lining of the first stomach is worn and ulcerated in patches and in some cases seems to have commenced decomposition; is very soft and can be peeled off the muscular layer with thumb and forefinger in big pieces. Lungs and heart almost bloodless, but the brain, particularly the cerebellum, is purplish, soft and pulpy.

The symptoms, etc., vary considerably, and it seems unlikely that one poison causes them all.

Four common plants are here said to "loco" stock, viz.: Oxytropis Lamberti, Leucocrinum montanum, Fritillaria pudica and Zygadenus elegans. The first is now known to produce no evil effects except when

eaten in large quantities for days together. Proper experiments have not been conducted with the others yet. Leucocrinum montanum is said to be very fatal to sheep after the fruit has developed. It grows close in the grass, and its narrow grass-like leaves are not easily avoided by stock. This plant occurs in various parts of the territory, is very common in Lewis and Clarke county, near Helena, and in the Sand Coulee region of Cascade county. Fritillaria pudica is almost the first plant to flower in spring. Before the grass is green horses and sheep often nip off the leaves. The scaly bulb is somewhat acrid to the taste. Zygadenus elegans does not flower so early but sends up its long "grassy" leaves at the same time. Sheep eat much of this plant, even nipping off the panicles when they appear. The whole plant is acrid, but the deep-set bulb is strongly so.

So many sheep, cattle and horses die yearly in all the western territories, presumably through eating poisonous plants, that western botanists should do all in their power to investigate the matter. Not long ago it was reported that a new disease had broken out among horses ranging on the northern foothills of the Great Belt Mountains. The disease first affects digestion only, and victims rapidly lose flesh and get very weak. Soon the renal regions are involved, and although sufferers seldom die they as seldom appear to fully recover; the back remains so weak that no load can be borne or drawn. One man has thirty fine-looking horses affected in this way. As usual, the cause is attributed to "some weed they get."—F. W. ANDERSON, *Great Falls, Montana.*

New Mosses.—Descriptions and drawings of the following new species and of many new varieties, by F. Renauld and J. Cardot, will be issued shortly in the BOTANICAL GAZETTE:

Dicranella Langloisii.—Louisiana (A. B. Langlois).
Dicranum consobrinum.—Minnesota.
Didymodon Hendersoni.—Oregon (L. F. Henderson).
Grimmia tenerrima.— " "
Coscinodon Renauldi.—Kansas (Henry).
Ulota glabra.—Oregon (L. F. Henderson).
Hendersoni.— " "
Orthotrichum productipes.—Oregon (L. F. Henderson).
Bryum crassum.— " "
Hendersoni.— " "
extenuatum.— " "
Fontinalis Kindbergii.—Vancouver (John Macoun). Oregon (L. F. Henderson).
subbiformis.—Oregon (L. F. Henderson).
Brachythecium Idahense.—Idaho (Leiberg).
Microthamnium aberrans.— " " A very interesting moss, of a tropical genus, with the facies of *M. acrorrhizum* (Hsch.) from Brazil, but distinct from all the known species of the genus in the broad, lax cells of the areolation.

The study of Fucus in inland laboratories.—The Fucaceæ are among the most interesting and instructive of the algæ, especially in regard to their reproduction, but unfortunately being strictly marine, they are not easily accessible, at least in the living state, to inland students.

It may be of interest to some of the readers of the GAZETTE to know that this difficulty is not by any means so great as is generally supposed, and that with a little care they may be shipped in good condition for long distances. Last winter (Feb. 3), I received through the kindness of Mr. F. S. Collins, of Walden, Mass., a lot of Fucus, mostly F. vesiculosus, but including also F. platycarpus and F. furcatus. They were simply gathered wet and wrapped in oiled cloth so as to prevent drying, and arrived in perfect condition.

Not having sea-water on hand, a solution of common salt of approximately the same density as ordinary sea-water (3 per cent.) was tried and found to answer admirably. My object was to study the fertilization, and this succeeded perfectly. If the plants are exposed for a few hours to the air, the ripe sexual organs will be exuded from the conceptacles in masses of considerable size. In F. vesiculosus, which is diœcious, the male and female plants are at once recognizable by the different color of the mucilaginous drops which ooze out from the mouths of the conceptacles; the masses of antheridia being orange yellow, while the oogonia are olive brown.

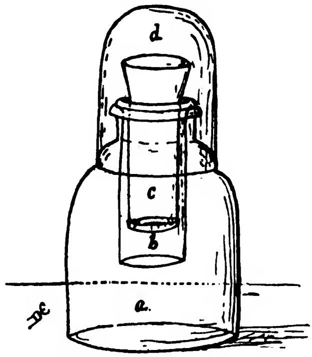
If now a drop from each plant is placed in a drop of the salt water, in a very short time the antheridia will discharge their contents and the water will be fairly alive with the spermatozoids. Shortly after the ova are set free, and almost immediately are surrounded by numerous spermatozoids, which attach themselves to the surface and often are so numerous as to set them in rotation, presenting a most extraordinary sight.

It is best to put the oogonia in the water first and wait until a number of the ova are discharged before putting in the antheridia, as in this way a supply of freshly discharged and active spermatozoids is assured. Care should be taken, too, to support the cover glass with a bit of paper, or some similar object, in order to avoid pressure on the oogonia.

The above experiment was suggested by the account of Fucus in Strasburger's "Botanisches Praktikum,"[1] in which, however, he seemed to think that sea-water was necessary.—DOUGLAS H. CAMPBELL, *Bloomington, Indiana*. ["Sea salt" can be procured at most druggists' and might profitably be substituted for common salt.—EDS.

[1] First German Edition, page 386.

Schultze's dehydrating apparatus.—The accompanying figure shows a very convenient and simple arrangement for gradually dehydrating small objects. It consists of a wide-necked bottle (*a*), into whose neck is fitted a short tube (*b*), and within this a similar but smaller tube (*c*). In order to prevent these tubes from slipping down, the upper part is widened into a small funnel. Each of the tubes has the bottom closed by a piece of parchment paper, which is carefully gummed on. The object to be dehydrated is placed in the tube *c*, which is partly filled with weak alcohol (about 30 per cent.), and this is then placed in the tube *b*, which in turn is put into the neck of the bottle *a*, which has been filled with absolute alcohol. By the diffusion of the fluid through the membranes covering the bottom of the tubes *b* and *c*, the density of the fluids will finally become the same, and the object in *c* will thus gradually be brought into practically absolute alcohol. The cover, *d*, effectually prevents evaporation and at the same time keeps out dust.



DEHYDRATING APPARATUS.

In order to prevent the alcohol in *a* from becoming too much diluted, it is best to use a very small amount of the weak alcohol, and a little calcined copper sulphate placed in the bottom of the bottle will absorb what little water may be present.

Usually two or three hours is sufficient for completely dehydrating most objects, but naturally large ones may take longer. Of course the process may be expedited by covering the bottom of only one of the tubes with the membrane, but it is usually better to have the diffusion take place rather slowly.—DOUGLAS H. CAMPBELL, *Bloomington, Ind.*

CURRENT LITERATURE.

On Nematophyton and Allied Forms.[1]

Prof. Penhallow has presented in this short memoir a most valuable contribution to our knowledge of one of the oldest and most perplexing forms that has claimed the attention of paleobotanists. The original material was collected by Sir W. E. Logan, from the Erian sandstones of Gaspe, about 1852. It was first examined by Dr. (now Sir) William Dawson in 1855, who recognized at once the extreme interest attached to the

[1] PENHALLOW, D. P.—On Nematophyton and Allied Forms, from the Devonian of Gaspé, with introductory notes by Sir William Dawson. Trans. Roy. Soc. Canada. Vol. VI. Sect. IV, 1888, pp. 27–47. Pl. I, II.

discovery. After carefully studying the available material it was published by Dawson under the name of *Prototaxites Logani* with the following diagnosis : "Woody and branching trunks, with concentric rings of growth and medullary rays; cells of pleurenchyma not in regular lines, cylindrical, thick-walled, with a double series of spiral fibers; disks or bordered pores few, circular and indistinct. The specimens are usually silicified, with the bark in a coaly state." Although Dawson states in the notes accompanying Prof. Penhallow's paper that he did not intend to imply its coniferous nature, the fact that it was named *Prototaxites*, and compared with the Aporoxylon of Unger and with the wood of various conifers, was taken to imply its taxine nature, and it was for a long time regarded as one of the oldest ancestors of our modern conifers.

Carruthers was the next to take up the subject. He obtained similar material from the Silurian of Wales, and concluded from its examination that it was the trunk or stem of a gigantic sea-weed. He therefore named it Nematophycus.

It was with a view of settling, if possible, the question of its affinities, that the examination of Prof. Penhallow was undertaken, with the aid of a more extensive and perfect series of specimens. His results, which may be taken as final, fully confirm those of Carruthers. He says "that it is an alga admits of no doubt; and so far as the structure alone will permit a final decision, its affinity with the Laminariaceæ as first pointed out by Mr. Carruthers, who therefore assigned it to the genus Nematophycus, appears to be highly probable."

Dawson has accepted their conclusions, and in his recently published "Geological History of Plants" has modified the name to Nematophyton. The original species becomes N. Logani, and Prof. Penhallow has described a new species, N. laxum, from the lower Erian of Gaspe, which with the Wales species, N. Hicksii, makes up the present known forms.

Prof. Penhallow also describes some very peculiar laminated fossils associated with Nematophyton Logani. They have the appearance of being matted and crumpled masses apparently of fronds, and although the structure is very badly preserved, are fairly comparable to the fronds of the Laminarieæ. They may possibly have been the fronds of Nematophyton, but this is merely conjecture, as they were not found in actual contact.—F. H. K.

Die fossilen Pflanzenreste.[2]

Paleobotany has passed beyond the stage in which the entire body of its workers are devoting their energy to mere description of species, and has entered upon broader, philosophical grounds. That this is true, is shown by the publications of Williamson, Ettingshausen, Renault, Solms-Laubach, and now by the admirable résumé by Dr. Schenk. It is, of course, true that this broader view is only possible after the accumula-

[2] SCHENK, DR. A.—Die fossilen Pflanzenreste. Sonderdruck aus dem Handbuch der Botanik, Bd. IV. Breslau, Verlag von Edward Trewendt. 1888.

tions of data have been made by isolated, individual workers, but it is none the less true that these scattered facts require to be sifted through a philosophical mind before they can be presented as a connected whole. It is a connected view of this general character that the work before us furnishes.

This volume is taken from the magnificent Handbuch der Botanik that is being prepared under the supervision of Dr. Schenk by a number of noted specialists. It is really intended as an introduction to the study of paleobotany, but it also contains a very considerable amount of discriminative matter. In the short introduction he points out the value of the study of plant remains, not only to geology, but principally in regard to the light it throws upon the evolution of existing vegetation. The characters which can be most relied upon in the identification of fossil plants are next discussed. Only a comparatively few plants are so so preserved as to retain their internal structure in suitable condition for study, and for their characterization recourse must be had to marks that in living plants are usually overlooked or ignored. The most important character is that furnished by nervation. The ferns, for example, in which the fructification is not preserved, are arranged according to certain comparatively few types of nervation, which careful study has shown to be reasonably reliable. So, also, with dicotyledons and monocotyledons. Most of the genera can be as clearly identified by the outline and nervation of the leaves as they could be if the whole plant was accessible. The arrangement of cones, scales and leaves in the conifers furnishes a similar key to their positive determination. But, as Williamson long ago pointed out, the internal structure furnishes the most valuable of all data.

The methods or conditions under which plants become fossilized are next described. Incrustation, petrifaction, and the more or less complete change to coal are the three conditions. Then follows the main portion of the work, viz.: an exposition of our present knowledge concerning the various types of vegetation that have been found fossil, and the light thrown by them upon existing vegetation. Beginning with the fungi, for example, it is shown how the various types first appeared in time, and a brief discussion is given of the more important or critical forms. The algæ are similarly treated, especial stress being laid on many doubtful forms that are now under discussion by botanists and zoologists. From these lower forms, the types of vegetation occurring in a fossil state are passed in systematic review, coming ultimately to the higher forms which occur in the later geologic formations and are found both fossil and living at the present day.—F. H. K.

Minor Notices.

THE AUSTRALIAN FLORA has been carefully studied, and many good descriptive and illustrated works published, one of the latest of which is

a thick octavo on the useful indigenous plants, by J. H. Maiden,[3] curator of the Technological Museum of New South Wales. The plants are treated alphabetically under the following headings: Human foods, forage plants, drugs, gums and kinos, oils, perfumes, dyes, tans, timbers, fibers, and miscellaneous. The book is admirably arranged and contains a large amount of useful information, all authenticated by abundant references to sources of information. There are fifty double-column pages of indexes.

THE FIRST FASCICLE of twenty-five Kansas fungi has been distributed by Kellerman and Swingle, of Manhattan, Kansas. The object is to include species never before issued, or on new hosts, or because otherwise noteworthy. The specimens are ample, of excellent quality, and are neatly put up and labeled. The present fascicle contains four species of Cercospora, three of Puccinia, two each of Æcidium, Glœosporium, Peronospora and Septoria, and one each of the ten remaining genera, all being parasitic forms. The series promises to be a valuable addition to American exsiccati. Those who are not so fortunate as to be remembered in the distribution can purchase of the authors at $1.25 per fascicle until the edition is exhausted.

NOTES AND NEWS.

MRS. LYDIA S. BENNETT, a well known botanist at Fisk University, Tenn., died March 16.

PROF. PETER, of the University of Göttingen, desires seeds of North American species of Hieracium.

MR. A. A. CROZIER has resigned his position as botanist of the Iowa Agricultural Experiment Station. His address at present is Ann Arbor, Mich.

THE LIBRARY of Leopold von Ranke, recently placed on the shelves of the Syracuse University, although mainly historical, yet contains some scientific serials of special value. The largest of these are the *Abhandlungen* of the Berlin Academy, 1788 to 1886, 81 quarto volumes; the *Sitzungsberichte* and *Monatsberichte* of the Academy of Sciences of Berlin, together making 44 volumes; the *Zeitschrift der Gessellschaft für Erdkunde* of Berlin, 1839 to 1885, in 52 volumes; the *Sitzungsberichte* of the Imperial Academy of Sciences at Vienna, 1848 to 1886, 113 octavo volumes, and the *Denkschriften* of the same Academy, in 35 royal quartos; the *Atti* of the Academy of Sciences at Turin, 1865 to 1886; the *Bulletin* and *Annuaire* of the Royal Academy of Belgium, the two series making 169 volumes; the long series of the *Jaarboek* of the Royal Netherland Institute; the *Verslagen* and *Verhandelingen* of the Royal Academy of Sciences at Amsterdam, and reports and memoirs of the scientific societies of Upsala, Copenhagen, St. Petersburg and Dublin. Altogether a fine reference collection of serials for the scientific workers of the institution and vicinity.

[3] MAIDEN, J. H.—The useful native plants of Australia, including Tasmania. pp. 696 8vo. Sydney and London: 1889.

VOL. XIV. NO. 8.—BOTANICAL GAZETTE.—AUG., 1889.

Notes on Fungi. I.

W. G. FARLOW.

In my paper on *Peronosporeæ* (BOTANICAL GAZETTE, viii. 335), the statement was made that the Cystopus parasitic on *Convolvulaceæ* in the United States was apparently the same as the *Æcidium Ipomœæ-panduranæ* of Schweinitz, *Syn. Fung. Car. Sup.* no. 454, and a doubt was expressed as to whether it should be united with the *C. cubicus* (Strauss) Lev. which infests *Compositæ*, although the conidia of the two forms are much alike. At that date the oospores of the form on *Convolvulaceæ* had not been seen, and I suggested that they should be sought in the stems and petioles rather than in the leaves. In the autumn of 1888 I received from Prof. L. H. Pammel some very interesting specimens of swollen stems of *Ipomœa pandurata*, collected at Valley Park, near St. Louis, Mo., in which he had found the oospores in abundance, while the accompanying leaves were covered with conidia. The swellings of the stems were very striking, and in one fine specimen the tumor formed by the hypertrophied parenchyma of one side of the stem was six inches long and somewhat over an inch in diameter, while the stem itself, whose diameter was not greater than a quarter of an inch, was bent over in the form of a horse-shoe by the growth of the unilateral tumor. The surface of the tumors when fresh was continuous, but in drying they cracked open and the inner portion was exposed in numerous places. Microscopic examination showed that the oogonia were different from those of any other Cystopus known to me, since their walls were not smooth, but raised in blunt papillæ, or short flexuous ridges over their whole surface. In the younger oospores the smooth-walled antheridia were in marked contrast with the papillate oospores, and the pollinodia were larger and more prominent than in other *Peronosporeæ*, so that the present species is remarkably well adapted for the study of the fertilization in this order. The oogonia are very irregular in shape, appearing in some sections nearly triangular, and their average diameter is 45μ. The oospores are on an average about 36μ in diameter, with an endospore 3μ thick. The

exospore is thinner and yellowish-brown in color, and apparently somewhat papillate, but the markings are masked by those of the overlying oogonium wall, and as the specimens examined were not quite mature, it was difficult to free the oospores from the oogonia. The markings of the exospore are certainly much less prominent than in C. candidus.

As the oogonia and oospores differ decidedly from those of C. cubicus, called in recent works *C. Tragopogonis* (Pers.) Schroeter, the present form can not be included in that species, to which it was referred in 1874 in *Grevillea*, iii. 58, and where it is still placed in Saccardo's *Sylloge Fungorum*, vii. 234, 1888. In 1883 Zalewski in *Bot. Centralbl.*, xv. 223, under the name of *C. Convolvulacearum* Otth, described the oospores of the Cystopus on Convolvulus Siculus in Southern France, and on C. retusus in Guadeloupe, and referred the North American form on Ipomœa Batatas to the same species, although he had not seen oospores in the latter case; and Zalewski's name was adopted by Kellerman in *Trans. Kansas Acad. Sci.* x. 94, and by Ellis in *N. A. F.* no. 1809. Being unable to ascertain where the name cited by Zalewski was originally published by Otth, I applied for information to Dr. Ed. Fischer, of Berne, who kindly informed me that there were specimens in the Otth herbarium marked *C. Convolvuli* Otth on C. Siculus from Hyères, but that he was unable to find out when or where the species was published by Otth. Probably the name of Otth is a manuscript name, and we may regard Zalewski as the proper authority for the name C. Convolvulacearum, which name is not quoted in the *Sylloge* of 1888. The description of Zalewski makes no mention of the characteristic papillate oogonia, and his account of the markings of the oospores does not agree with those seen in Prof. Pammel's specimens, but when quite mature the latter might have become more distinctly marked.

Undoubtedly the first name given to the form on *Convolvulaceæ* in North America was *Æcidium Ipomœæ-panduranæ* Schweinitz, for an examination of an authentic specimen of Schweinitz shows that it is certainly a Cystopus identical, so far as can be told by the conidia, with the Cystopus known in this country on *Ipomœa Batatas* Lam., *I. Jalapa* Pursh., *I. pandurata* Meyer, *I. leptophylla* Torr., *I. commutata* Rœm. & Sch., *I. Nil* Roth., and *I. hederacea* Jacq. To this form is apparently also to be referred the Cystopus reported by me (Botanical Gazette, viii. 335), as growing on cotton leaves in

Alabama. The leaves were sent to me as cotton leaves, to which they bear a strong resemblance, but a microscopic examination shows that they can not be cotton leaves, but probably leaves of some Ipomœa or Convolvulus. The date of the original Schweinitzian name is 1822, which must be prior to any name of Otth, even if I am mistaken in supposing the name cited by Zalewski to be merely an herbarium name of Otth. In 1834 Schweinitz in *Syn. Fung. Am. Bor.* no. 2866 changed his original name to *Cæoma Convolvulatum*, and in *Grevillea*, iii. 60, Berkeley and Curtis enumerated *Æcidium Ipomœæ* Schw. on I. trichocarpa, the same as I. commutata mentioned above. Æcidium Ipomœæ is apparently an abbreviation of the name in the *Syn. Fung. Car.* In the *Sylloge*, vii. 671, Berlese and De Toni give Æcidium Ipomœæ-panduranæ as a synonym of *Puccinia Ipomœæ* Cke., based on the specimen in Ravenel's *Fungi Americani*, no. 792. This is an error, for the æcidium in the specimen named is certainly not the true *Æc. Ipomœæ-panduranæ* of Schweinitz, but what is called by Cooke, in *Grevillea*, xiii. 6, *Æcidium Convolvuli* Schw. var. *Ipomœæ*.

In this connection it may be said that Cystopus cubicus has been found on Matricaria at San Diego by Mrs. Eigenmann, and on Perityle Californica, var. nuda, in Lower California. The last named specimens, received from Mr. Colville, contained ripe oospores.

Last autumn I received from Mr. K. Miyabe a very interesting Peronospora, found by Mr. Y. Tanaka on Cucumis sativa in the preceding June at Minoma, Tokio, Japan. The dried material received was accompanied by some excellent drawings, showing not only the conidia, but also illustrating the germination, which was by means of zoospores. The Peronospora hitherto known on *Cucurbitaceæ* in the United States is *P. australis* Speg., *P. sicyicola* Trelease of my previous paper. In the *Sylloge Fungorum* P. australis and P. sicyicola are described separately, but there can be no doubt that they are the same species, since not only does Spegazzini's excellent description answer to our plant, but specimens which were sent to him were pronounced by him to be certainly the same as the South American plant. The germination of the conidia of P. australis has not been seen, but the pinnate branching and condensed spiny tips of the conidiophores, and the general character of the spores are so much like those of such species as P. viticola and P. Halstedii, which are known to produce zoospores, that it might be supposed that it would also produce zoospores.

The same would not have been expected in the case of the Japanese Peronospora, for its aspect is unlike that of most of the zoosporiferous forms placed by Schroeter in the genus Plasmopara. The Japanese fungus is less conspicuous to the naked eye than P. australis, and covers scattered spots on the underside of the leaves with a thin down. The conidiophores are not densely tufted in the stomata, but are either solitary or grouped in small numbers. They have an average breadth of from 4–6μ and generally reach a height of 25–30μ before they begin to branch. The ramification is typically pinnate, the branches being given off at rather a wide angle, but not at right angles as in P. viticola and P. Halstedii. The main branches are again loosely once or twice pinnate with straight, filiform, widely diverging tips. Occasionally there is an appearance of forking, owing to the exceptionally luxuriant growth of the lower branches, but the typical branching is certainly pinnate rather than dichotomous. Compared with the conidiophores of other species the present form is marked by its slender naked main axis bearing a loose tuft of branches near the tip. The spores are obtusely oval, from 21–25μ long by 15–18μ broad, 25μ by 18μ being very common. They are slightly papillate and, when mature, of a dingy violet color. Oospores were not seen by me. The species is said to occur in Japan on one other cucurbitaceous plant besides Cucumis sativus, but I am unable to give the name of the second host.

Mr. Miyabe has fortunately been able recently to examine the specimens of *Peronospora Cubensis* B. & C. in the Berkeley collection at Kew, and finds that the Japanese fungus is identical with that species. The species is interesting biologically because, as a rule, the conidial spores of those Peronosporæ which produce zoospores are small and cuboidal in shape, while the large oval and violet colored spores of the present species suggest rather species placed by de Bary in the section Pleuroblastæ. The range of the species is also interesting. Found first in Cuba by C. Wright, it has not been seen again until discovered in Japan in 1888, and during the present year in New Jersey, where it was found by Professor Halsted on cucumbers. The latter specimens agree perfectly with those from Japan, and Professor Halsted informs me that he has also been able to see the germination of the conidial spores by zoospores, thus confirming the observations made in Japan by Mr. Tanaka.

Cambridge, Mass.

Notes on our Hepaticæ.

LUCIEN M. UNDERWOOD.

I. NORTHERN SPECIES.

In a recent address, Simon Newcomb made the prophecy that the time would come when he who made a discovery in the literature of a science would be entitled to as great recognition as he who made a discovery in nature. With the sharply defined division of labor and the elaborate systems of indexing now in use this is hardly likely to prove true in botanical science; yet we have not passed the time when the discovery of forgotten works does not produce extensive upheavals in the nomenclature of long established species and supplants names long familiar by others often less euphonious and simple. In the literature of the Hepaticæ two works, neither of which has any special merit or originality, have been the source of much contention and difference of opinion, and, in connection with the earlier works of Necker[1] and Raddi[2], really form the foundation of generic distinctions among the Hepaticæ. Copies of these works, though long sought for, have only recently come into our possession. They bear the titles: "A Natural Arrangement of British Plants," by Samuel Frederick Gray, 2 vols. London, 1821, and "Commentationes Botanicæ. Observations Botaniques par B. C. Dumortier." Tournay, 1822.

In the first named work the species of Jungermania, of which the British species had been elaborately monographed by the elder Hooker five years before[3], were placed in new genera, which, for the greater part, corresponded to the sections already indicated in Hooker's work. The genera thus established were: Riccardius, Pallavicinius, Herverus, Papa, Blasia, Maurocenius, Salviatus, Pandulphinus, Marchesinus, Cavendishia, Martinellius, Mylius, Nardius, Jungermannia, Bazzanius, Scalius, Cesius, Herbertus[4], Lippius, and Kantius. Of these Blasia had been named by Micheli[5], and adopted by Linnæus; Hooker, however, had united it with

[1]Elementa Botanica, 1790.

[2]Jungermannisgrafia Etrusca in *Atte d. Soc. Ital. d. Scienze*, XVIII, 1-45 (1818).

[3]British Jungermanniæ, 1816.

[4]In the text (vol. I, pp. 684, 705) this name is given to two entirely distinct genera; the former, however, is changed to Pallavicinius later in the volume (p. 775).

[5]Nova plantarum genera, 1729.

Jungermannia. Jungermannia was first established by Rappius[6], and being adopted by Linnæus and all subsequent writers, stands to-day as the typical genus of the order. Cavendishia was a name given for a group of plants which had been designated as Porella by Dillenius[7], and which, singularly enough, had been placed by Linnæus with the Musci; the genus in question has latterly been more commonly known under the name of Madotheca. Of the other genera Herverus, Papa, Maurocenius and Salviatus had already been named by Raddi[8] as Metzgeria, Pellia, Fossombronia and Frullania, respectively. Pandulphinus had also been named Lejeunea by Madamoiselle Libert a year before[9]. Several of Gray's genera, with the termination properly changed to the feminine form, are now adopted by most hepaticologists; among these are Pallavicinia, Mylia, Nardia, Bazzania, Scalia, Herberta, and Kantia[10]. Cesia and Lippia must yield to names previously given to genera of flowering plants. This leaves two genera, Riccardia and Martinellia, concerning which there is considerable difference of opinion, the names being adopted by some and rejected by others; a statement of the question of their adoption, which presents some interesting problems bearing on the question of priority, will be stated below.

In Dumortier's work, which covers a wide range of botanical matter, chapitre cinquieme is entitled *Essai d'une Monographie des Jongermannes*. The essential part of this essay of fourteen pages is a division of the pre-Linnæan genus Jungermania into nineteen genera, as follows: Codonia, Madotheca, Lejeunea, Phragmicoma, Jubula, Radula, Mesophylla, Jungermania, Thricbrolea, Saccogyna, Cincinnulus, Schisma, Marsupella, Mniopsis, Dilæna, Fasciola, Aneura, Scopulina, and Blasia, all of which, except Jungermania, Lejeunea and Blasia, were new. As Dumortier was ignorant of the work of either Raddi in Italy or Gray in England, he naturally duplicated several genera. Thus Madotheca = Porella Diel. Fasciola, Codonia and Scopulina are, respectively, Metzgeria, Fossombronia and Pellia of Raddi; while Dilæna, Mesophylla, Mniopsis, Schisma and Cincinnulus are the equivalents of Pallavicinia, Nardia, Scalia, Herberta, and Kantia of Gray. Jubula, although

[6]Flora Jenensis, 2d ed., 1726.

[7]Historia Muscorum, 1741.

[8]Loc. cit.

[9]In *Ann. gen. sc. Phys.* V, 372 (1820).

[10]A contribution of interest on Gray's genera, by Dr. Carrington, may be found in volume X of the Transactions of the Botanical Society, Edinburgh (1870).

originally including Raddi's species of Frullania, had for its type species *Jungermania Hutchinsiæ* Hooker, and as this is the type of a very distinct genus, properly retains this name. Phragmicoma, although preceded by Gray's Marchesinus, has stood as a genus until recently, when it has been united with Lejeunea by one of the masters in hepaticology in his recent revision[11]. The distinctive characters of Marsupella have been pointed out, and it has been re-established by the same masterly hand[12]. Thricholea (afterwards changed by Dumortier himself to Tricholea, and by Nees corrected to Trichocolea) and Saccogyna still stand as good genera. This leaves the two genera, which have been referred to already, Aneura and Radula. The case of the first is rather simple: Riccardius, established by Gray, contained three Linnæan species, viz: Jungermania multifida, J. pinguis and Riccia fluitans. Aneura, established a year later by Dumortier, contained four, viz: Jj. multifida, sinuata, pinguis and palmata. The name Riccardia, being preoccupied elsewhere, as is the earlier Candollea of Raddi, there seems little reason why Aneura should not be maintained, excluding, of course, the third species of Riccardius, which Gray, attracted by superficial resemblance, had erroneously placed here.

The other case is more complicated. Gray established the genus Martinellius, of which the first-named species was Jungermania complanata L., followed by eight others, including J. nemorosa and J. spinulosa. A year later Dumortier established the genus Radula, of which the first species was the same J. complanata L., followed by, essentially, the same species. In a later work Dumortier[13] divided this genus into three sections: 1. Radulotypus, of which complanata is the type; 2. Scapania, of which nemorosa is a type; and 3. Plagiochila, of which spinulosa is a type. Still later[14] he established the two latter sections as genera which have since been properly recognized as such, and with the advance of the study in other regions have so grown as to contain a very extensive array of species. If we are to adopt Gray's nomenclature in this case, the name Radula must certainly be displaced by Martinellia, as Dr. Carrington has well observed[15]. What then becomes of Radula, the next oldest

[11]RICHARD SPRUCE. Hepaticæ of the Amazon and of the Andes of Peru and Ecuador. Trans. and Proc. of the Bot. Society (Edinburgh) XV. (1885).

[12]Revue Bryologique, VIII, 89–104 (1881).

[13]Sylloge Jungermannidearum Europæ indigenarum, 1831.

[14]Recuiel d'Observations sur les Jungermanniacées, 1835.

[15]British Hepaticæ, p. 52.

name? Shall it displace Scapania or Plagiochila? Or in a case which involves so much difficulty and can certainly disturb nothing outside of the three genera in question, is it not the part of wisdom to reject Gray's name and leave the three names so long established intact, as has been done by Spruce, Carrington, and most of the English school. In any case the adoption of Martinellia for Scapania, as done by Dr. Lindberg, is unwarranted.

The relations of these early established genera may be made more clear by the following table:

Raddi *1820*	Gray *1821*	Dumortier *1822*	
Rœmeria	=Riccardius	=*Aneura*	
	Pallavicinius	=Dilaena=Steetzia Lehm 1846.	
Metzgeria	=Herverus	=Fasciola	
Pellia	=Papa	=Scopulina	
Fossombronia	=Maurocenius	=Codonia	
Frullania	=Salviatus	=Jubula	
	Pandulphinus	=*Lejeunea* Libert 1820.	
	Marchesinus	=Phragmicoma	=*Lejeunea* Spruce
Antoirea, Bellincinia	=Cavendishia	=Madotheca	=*Porella* Dill. 1741.
Candollea	=Martinellius	=Radula	*Radula* Dum. 1835. *Scapania* Dum. 1835. *Plagiochila* Dum. 1835.
	Mylius	=	
	Nardius	= Mesophylla, Marsupella	
	Bazzanius		
		Thricholea	=*Trichocolea* Dum.
	Scalius	=Mniopsis	
	Cesius	= Schisma	=*Gymnomitrium* Nees, 1833.
	Herbertus	= Schisma	=Sendtnera Nees, 1845.
	Lippius	= *Saccogyna*	
Calypogeia=	*Kantius*	=Cincinnulus	

Since the publication of the Descriptive Catalogue[16], many changes have become necessary, some of which had escaped notice at the time of publishing that paper because of the absence of much of the scattering hepatic literature, and many more from the investigations made since its publication. In the review of the species of the "manual region" the following changes become necessary, and since necessary the sooner we become familiar with them the better:

Frullania Grayana (p. 66) becomes F. Asagrayana, the original form of the name, which has been misquoted by Americans in its shortened form, beginning with Sullivant. "Frullania Hutchinsiæ var." (p. 65) becomes *Jubula Hutch-*

[16] Underwood. Descriptive Catalogue of North American Hepaticæ, north of Mexico. In. *Bull. Ill. State Lab. Nat. Hist.* II, 1-133 (1884), to which page references are made in the corrections.

insiæ (Hook.) Dum., var. *Sullivantii* Spruce, described in full in his *Hepaticæ of the Amazon*, p. 62.

Phragmicoma clypeata (p. 73) becomes *Lejeunea clypeata* (Schw.) Sulliv., to which *L. calyculata* Tayl. (p. 69) is reduced as a synonym based on an examination of Taylor's specimen in the Gray Herbarium. L. cucullata (p. 71 not of Nees) becomes *L. diversiloba* Spruce, the true *L. cucullata* Nees being a Javan plant.

L. echinata Tayl. (p. 72) is properly *L. calcarea* Libert, as the species was originally named in 1820. The use of Taylor's name illustrates one of the pernicious principles that has been introduced into the system, and is even now maintained by some botanists. The plant was first described by Hooker in 1816 under the varietal name "Jungermannia hamatifolia *B* echinata." Madamoiselle Libert describes it as a species in 1820 as a type of her new genus Lejeunea with the specific name, "calcarea"; Taylor, in 1844, rejected Madamoiselle Libert's name and revived the varietal name of Hooker, which plainly has no claim to priority, not having been used by him as a *specific* name.

L. testudinea Tayl., *L. cyclostipa* Tayl., *L. polyphylla* Tayl. and *L. longiflora* Tayl., should all be stricken from our flora, Spruce having pointed out the fact that they are all South American species, erroneously reported from Ohio by mistakes in labels.

Madotheca (p. 74) must be replaced by the pre-Linnæan name Porella of Dillenius. It is a singular fact that the name Madotheca should have remained so long undisturbed, since Linnæus himself adopted Dillenius' name, although he erroneously placed the plant among the Musci. Our species become *P. pinnata* L. (= Madotheca porella, p. 76), *P. platyphylla* (L.) Lindb. (p. 75), *P. thuja* (Dicks.) Lindb. (p. 75), *P. rivularis* (Nees.) (p. 74), and *P. Sullivanti* (Aust.) (p. 75). Blepharozia (p. 80) returns to Ptilidium and our species is *P. ciliare* (L.) Nees. Another erroneous principle of nomenclature is here illustrated. Blepharozia was established as a sectional or subgeneric name by Dumortier in his *Sylloge*, 1831, but was not raised to generic rank until 1835; meanwhile (1835) Nees had established for the same plant the genus Ptilidium, which must stand as the first *generic* name.

Sendtnera (p. 81) becomes Herberta, as noted above, and our species is *H. adunca* (Dicks.) S. Gray.[17]

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17 Our species has erroneously been referred to S. juniperina, which is a much more robust species of tropical America.

Cephalozia catenulata (p. 95 *et Auct. Amer.*, not of Lindenb.) is a new species described by Spruce under the name of C. Virginiana.[18]

C. multiflora (p. 94) was erroneously described by Lindberg and corrected by Dr. Spruce;[19] it should, therefore, read *C. multiflora* Spruce, with some alteration in the specific description.

C. Francisci, var. fluitans (p. 96), becomes *C. fluitans* (Nees.) Spruce.[20]

Calypogeia (p. 85) becomes Kantia, as noted above, and our species become *K. trichomanis* (Dicks.) S. Gray, and *K. Sullivanti* (Aust.).

Trichocolea Biddlecomiæ (p. 82), imperfectly described, presents no characters in the description which merit for it a specific rank. No specimens are in existence, so far as we can find; it will, therefore, drop from the list.

Scapania compacta, var. irrigua (p. 108), becomes *S. irrigua* (Nees) Dum. *S. breviflora* Tayl. (p. 110), as seen in Taylor's own specimen and drawing in the Gray herbarium, is a synonym of S. nemorosa. S. albicans, var. taxifolia (p. 108) is removed to Diplophyllum, and its nomenclature is *D. albicans* (L.) Dum., var. *taxifolium* (Nees).

Lophocolea minor (p. 89, Aust. *Hep. Bor.-Am.* No. 65b, not of Nees), is *L. Austini* Lindb., while L. crocata (p. 90, Aust. *Hep. Bor.-Am.* No. 65, not of Nees), is the true *L. minor* Nees, as pointed out by the late Dr. Lindberg.[21]

Chiloscyphus Drummondii Tayl. (p. 88) drops out of the list as a synonym of Harpanthus scutatus. There is a strange mortality among Taylor's American species, and further study of his private collection, which now forms part of the Gray herbarium, will doubtless be a profitable work in clearing up some problems in synonymy.

Coleochila (p. 97) becomes Mylia, as noted above, and our species is *M. Taylori* (Hook.) S. Gray.

Pleuranthe olivacea (p. 90), another of Taylor's species, is *Harpanthus Flotovianus* Nees.

Jungermania polita (p. 104 Aust. *Hep. Bor.-Am.* No. 46, not of Nees) is described by Dr. Lindberg as a new species, *J. laxa* Lindb.[22]

Marsupella Dum., following Dr. Spruce, is to be sepa-

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18 Spruce; on Cephalozia, 1882, p. 37.
19 Spruce, l. c. 37.
20 Spruce, l. c. 50.
21 Hepaticæ in Hibernia mense Julii, 1873, lectæ; in *Acta Soc. Scient. Fenn.* X, 503 (1875).
22 Loc. cit. 529.

rated from Nardia (p. 113) and our species become *M. sphacelata* (Gies.) Dum. (p. 114), *M. emarginata* (Ehrh.) Dum. (p. 114) and *M. adusta* (Nees) (p. 114). Nardia, however, receives a considerable accession from Jungermania as follows: *N. hyalina* (Lyell) Carr. (p. 102), *N. crenulata* (Sm.) Lindb.[23] (p. 101), *N. crenuliformis* (Aust.) Lindb. (p. 101), *N. biformis* (Aust.) Lindb. (p. 102), and *N. fossombronioides* (Aust.) Lindb. (p. 101) the last forming a distinct subgenus.

Cesia (p. 115) is preoccupied as Cæsia (R. Br. 1810) in the Liliaceæ; hence our species must be referred to *Gymnomitrium* (Nees, 1833) and becomes *G. concinnatum* (Lightf.) Dum.

Steetzia (p. 57) becomes Pallavicinia as noted above, and our species is *P. Lyellii* (Hook.) S. Gray.

The species which since the days of Schweinitz, the father of American hepaticology, has been confused under the name of A. palmata (p. 54), is a very distinct species which has been described as *A. latifrons* Lindb.[24]

Lunularia cruciata (p. 43) was described by Micheli long before Linnæus called it Marchantia cruciata; hence it must be called *Lunularia vulgaris* Mich.[25]

Duvalia (p. 35) and Grimaldia (p. 35) form one genus as early held by Bischoff[26] and later insisted upon by Lindberg[27], who, however, reduces all to the genus *Duvalia* (Nees, 1817). As there is an earlier *Duvalia* (Haworth, 1812) the species must be placed in *Grimaldia* (Raddi, 1818). Our species of Duvalia thus becomes *Grimaldia rupestris* Lindenb.

Riccia bifurca (p. 23) is omitted, there being no probability that it is a member of our flora.

Sphærocarpus Micheli (p. 30) has a much earlier name, *S. terrestris* Mich.,[28] which must take its place in our list.

Four species are known only from their original descriptions, no specimens, so far as we are aware, existing in any American collection; these are (1) *Frullania Pennsylvanica* Stephani, (2) *Jungermania Gillmani* Aust., (3) *J. Wattiana* Aust. and (4) *Cephalozia pleniceps* (Aust.) Und. These should be specially sought by collectors in the higher latitudes. Two species must be added to our list, viz.: (1) *Frullania dilatata* (L.) Nees, and (2) *Pellia endiviæfolia* (Dicks.) Dum., which has

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23 Loc. cit. 530.

24 Manipulus Muscorum Secundus, in *Notiser pro Fauna et Flora Fennica*, XIII, 372 (1874).

25 Micheli, loc. cit. 4, tab. 4.

26 Bemerkungen über die Lebermoose, in *Acta Acad. Cæs. Leop.* XVII, 1025 (1835).

27 Musci Novi Scandinavici, 285.

28 Micheli, loc. cit. 4, tab. 3.

hitherto been confused with P. epiphylla. Both of these are well known European species. This brings the flora of the "Manual region" to 140 species, which, as compared with the former publication in Gray's Manual by Sullivant, is an increase of 31 species. It should be noted, however, that from Sullivant's enumeration should be deducted: (1) those species which were then erroneously accredited to our district (5 species); (2) species included which have since been reduced to synonyms (8 species); and (3) species included in his list which were beyond the limits of the "Manual region" (13 species). After making these legitimate deductions, the ratio stands 83 to 140, which represents a fair advance when we consider the few who have studied or collected hepatics in America during the last twenty-six years.[29]

From Canada and the other British provinces are a considerable number of additions to report, due chiefly to the untiring energy of Prof. John Macoun. We wait the publication of these by their collector. We are now at work on a revision of the Pacific species, while a considerable number of additions collected in Florida by Capt. Donnell Smith, several years ago, have been generously placed at our disposal for study and will be examined at an early day. Two rare Southern species, *Riccia Donnellii* Aust. and *Thallocarpus Curtisii* Aust., will be distributed in the next issue of *Hepaticæ Americanæ* through the generosity of Dr. N. L. Britton, of Columbia College. Working, as time has permitted, almost alone for the past eight years, with almost no one who would or could collect in remote parts of the country, the study has at times been very discouraging. But times have changed; collectors are more abundant, and collect more intelligently; collections come to hand faster than the crowded leisure time of a busy professional life will serve to examine; but that there is an "awakening" in the study of these neglected plants, is a ground for hope for the future. There is as yet only a beginning made; the field is large enough for any number of workers.

Syracuse University.

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[29] The "4th Revised edition" of Gray's Manual on our table containing Sullivant's *Mosses and Hepaticæ of the Eastern United States* bears the date, March 10, 1863.

BRIEFER ARTICLES.

Studies in nuclear division.—It may not be generally known that nuclear division, in certain cases at least, may be easily and quickly studied, and a few hints here may not be out of place.

The readiest means of studying this interesting subject is probably to be found in the final divisions of the pollen mother-cells, especially of monocotyledons. I examined a number of plants recently, and among them found two in particular that showed very beautifully all of the stages in the division of the nucleus, including the longitudinal division of the nuclear segments[1], and were thoroughly typical representatives of the differences in the processes as found in monocotyledons and dicotyledons.

The first of these was Allium Canadense, the second Podophyllum peltatum.

Young buds must be used, in Allium about 2mm. in length; in Podophyllum buds were gathered as soon as the plants appeared above ground. In the former case the young anthers were crushed carefully in a drop of acetic acid and water (½ acetic acid and ½ distilled water). With Podophyllum cross-sections of the whole bud were made, and the sections of the anthers teased out in the same solution as in the case of Allium. The pollen mother-cells are at once recognizable by their thick colorless walls, and it is easy to tell with a low power whether or not the desired division stages are present. If this is the case they may be stained with acetic methyl-green, or better, gentian-violet. In preparing the latter the best results were had by first mixing two parts of distilled water and one of acetic acid. To this mixture a sufficient quantity of a saturated alcoholic solution of gentian-violet was added to give it a deep violet color. If a small drop of this mixture is now added to the preparation containing the pollen cells, the nuclei will be almost instantly colored a deep blue-purple, while the protoplasm remains colorless and entirely uncontracted. The coloring fluid may now be carefully removed with blotting-paper, care being taken, of course, to avoid removing any more of the floating pollen mother-cells than is necessary, and the preparation mounted in dilute glycerine, which must be added very gradually to avoid contraction of the protoplasm. Specimens prepared in this way, especially when first made, show all the finest details of the nuclear structure, and scarcely, if at all, inferior to those prepared by the much more tedious and uncertain methods of fixing by alcohol, chromic or picric acid, etc., staining with hæmatoxylon, carmine or safranin, and mounting in balsam.—DOUGLAS H. CAMPBELL, *Bloomington, Ind.*

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[1]The author expects later to publish a more extended account, with figures, of these two plants, with possibly some additional matter bearing on the subject.

Some notes on Hypericum.—In the BOTANICAL GAZETTE for April and May, 1886, was published my revision of North American Hypericaceæ; while in the number for October, 1886, were published further notes and a description of a new species, *H. lobocarpum* Gattinger, from the "oak-barrens" of W. Tennessee and probably W. Mississippi. A few additional notes are made at this time to record our present knowledge of this group.

The interesting new species H. lobocarpum was found growing abundantly near Lake Charles, Louisiana, in July and August, 1888, by Prof. W. W. Daves. The range of this species is therefore extended over the Lower Mississippi region, from Tennessee southward. It should be looked for in E. Arkansas.

I am informed by Dr. Watson that during Dr. Gray's last visit to Paris, in 1887, he re-examined the types of Hypericum there, and states positively that Lamarck's H. cistifolium is neither *H. opacum* Torr. & Gray, as he first thought, nor *H. nudiflorum* Michx., as I considered it in the revision, but *H. sphærocarpum* Michx. Therefore *H. sphærocarpum* Michx. must become *H. cistifolium* Lam., and H. cistifolium of my revision, not Lamarck, becomes again *H. nudiflorum* Michx.

Another correction may as well be made. Under *H. opacum* Torr. & Gray, in the revision, H. cistifolium is quoted as a synonym, with the authority "Watson, Bibl. Index. Polypet. 125, not Lam." This authority should be changed so as to read "Torr. & Gray, Fl. i. 674, and later authors, not Lam."—JOHN M. COULTER, *Crawfordsville, Ind.*

Sterility of violets.—It is a curious fact that with the remarkable arrangements for cross-pollination in numerous species of violets they rarely cross-fertilize. In order to assure myself of this conclusion, I removed a number to my garden several years ago. I have V. sagittata, V. pedata, var. bicolor, V. striata, V. Canadensis, V. palmata, var. cucullata, under observation, and, with the exception of one plant of the latter, I have never had a petaliferous flower bear seed. This one was growing on a very dry rockery. They all bear fruit abundantly from cleistogene flowers. The perfect flowers, on my grounds, are not cross-fertilized by insect or any other agency. They are not fertilized at all. Though environment (whatever that may mean) has undoubted influence on determining the development and functional powers of stamens and pistils, I incline to the belief that the same facts will be found generally elsewhere.—THOMAS MEEHAN, *Germantown, Penn.*

Dionæa muscipula.—I have had under observation a flowering plant of *Dionæa muscipula* Ellis, and the following notes may be of interest: Of the seven flowers of the irregular umbel, the uppermost opened first. The ten stamens were mature and copiously discharging pollen, while the style was small, and leaning towards one side, the stigmas undeveloped. Thirty-six hours later the fringed stigmas unfolded, and spread

out to receive pollen. This was repeated in the case of each flower, the time varying slightly. The flowers remain open three days, unaffected by light or shade; then the pure white petals begin to roll up like a scroll from the outermost edge inwards, inclosing the five stamens which grow opposite the petals, and leaving the others, which are opposite the sepals, still exposed. After a time, the sepals fold inwards over the fertilized ovary. The pollen is (as in the Heath family) compound, composed of four united grains, each one having spine-like projections, and showing thin oval spots on the surface. I cross-fertilized the flowers, and they give evidence of bearing seed.—CONSTANCE G. DUBOIS, *Waterbury, Conn.*

Observations upon barberry flowers.—In the common barberry (*Berberis vulgaris* L.) the anthers of the sensitive stamens dehisce by means of uplifted valves in such a manner that the pollen adhering to the inner surface of the valve (now turned inward) is brought against the rim of the large discoid stigma when the stamen is irritated. This position is secured by the valvular suture extending to the top upon the outside of the stamen (the whole valve being lateral), then by contraction the valve is folded inward and upward and the inner surface loaded with pollen is brought facing the pistil.

An examination of the stigma shows that there is a narrow belt of long stiff hairs surrounding the whole rim of the cup-shaped stigma. These hairs are abundantly provided with an adhesive substance, and the cushion or belt of hairs occupies that portion of the top of the style against which the anthers come when they bevel inward, and in an ordinary flower this zone is soon covered over with adhering pollen. All of the upper surface of the discoid stigma is covered with short papillæ as is also the deep cleft which extends downward into the style. In the examination of a large number of stigmas not a single pollen grain was found germinated in the brush of hairs, but above this, and of course at a point out of reach of the stamens of that flower, pollen tubes were not infrequent.

Paper sacks were placed upon branches bearing racemes of unopened flowers, and all insects thereby excluded. The blossoms were examined from time to time, and in all cases the pollen was abundant upon the brush, but none could be seen upon the stigma proper. Out of thirty racemes thus covered only four formed any fruit, and three of these berries were upon a branch over which the sack was defective, having a hole at the top. The other case may be a case of close fertilization, or an insect possibly worked its way into the sack from its base, where it might have been imperfectly folded around the stem. The flowers not covered by sacks upon neighboring branches or shrubs fruited heavily. The observations with microscope and the actual field experiments suggest that the brush is only a means for wide fertilization.—BYRON D. HALSTED, *New Brunswick, N. J.*

Notes upon Lithospermum.—The Hoary puccoon (*Lithospermum canescens* Lehm.) is a common prairie plant of high ground, flowering conspicuously in the month of May. This species is decidedly dimorphic, as has been previously observed by Dr. Bessey, and may be occasionally trimorphic, as reported by Mr. Smith, of Michigan. I have seen no indications of this last condition.

The styles of the long-styled flowers are from 6 to 11 mm., averaging 7.7 mm. Stamens in the same flowers are 3 to 4 mm., averaging 3.4 mm. above the receptacle. In the short-styled flowers the styles are 2 to 4 mm., averaging 2.9 mm.; and the stamens 7 to 8 mm., averaging 7.6 mm. The long or high stamens have short filaments ½ to ⅓ mm. long, attaching the anther to the corolla tube, while the short or low stamens are practically sessile.

It is, however, to the pollen of this plant that attention is called. That of the high stamens ranges from 11–13 by 22–25μ, with an average of 12 by 24μ. That of the short stamens varies frem 7–10 by 15–21μ, and averaging 8 by 17.5μ, or about two-thirds of the diameter of that of the high stamens.

The measurements are not easily taken owing to the peculiar shape of the grains, which consist of two large portions connected by an isthmus, the whole being somewhat dumb-bell shaped, with one end larger than the other. In fact the outlines made upon white paper by using the camera might be easily mistaken for representations of boot tracks in the snow.

Upon making comparative tests for germinative power, it was found that after a given period in sugar solution about one in fifty of the short-stamen grains had pushed out tubes of a length not exceeding the longer diameter of the grain. During the same time, twice as many of the larger grains produced tubes some of which were ten times the longer diameter of the pollen.

The tubes of the pollen from the high anthers need to grow through a longer distance of style and this may be sufficient reason for the greater vigor of each germinating grain, but the reason for the larger percentage of tube-producing grains may not be so apparent. It may be true that the difference in size in grains might render the same strength of sugar solution unequally favorable for growth.

Turning to the stigmas, there is a corresponding difference between those of the two lengths of styles. That of the long styles is 25 per cent. larger than of the short, and the papillæ of its surface are about twice as long.

Considerable attention was given to a corresponding study of another prairie puccoon, namely, Lithospermum angustifolium. I was not able to satisfy myself that the latter is distinctly dimorphic. There was a great variation in the lengths of the styles and stamens, but the age of the flower seemed to have much to do with this. The tube of the corolla elongates rapidly at the time when the lobes are spreading and the

growth carries the stamens upward. In the bud the style is uniformly longer than the stamens, but later on it may be equal to or shorter.

The pollen of this species is large and spherical, 47–50μ, with several prominent pores. There was no marked difference found between the grains from stamens of various lengths. There was also no evident difference between the stigma of the pistil with styles of various heights.

The remarkable difference between the pollen of the two Lithospermums may have its value in classification. In no other instance have I observed such wide dissimilarities in size, shape and markings within the same genus. As a rule, the pollen of a genus follows the same type with slight variations, except possibly in the matter of size. The differences might be termed generic, and in the proper classification the L. angustifolium may well be separated from the genus containing the L. canescens—in fact this is done in De Candolle's Prodromus, where the L. angustifolium is one of the species constituting the genus Pentalophus. —BYRON D. HALSTED, *Rutgers College, New Brunswick, N. J.*

CURRENT LITERATURE.

The genus Carex.

No genus is more severely let alone by the average botanist than this huge group of sedges. Our North American species have long been studied by Prof. L. H. Bailey, and his views have been set forth in a series of papers, published mostly in this journal, and in his monograph, which appeared among the *Proc. Amer. Acad.* publications for 1886. We have before us his latest contribution[1] to this subject, after having had the opportunity of seeing all the existing types of our North American species. This has been so thoroughly done, that almost every name which has been applied to N. Am. species is accounted for. This necessitates very many changes, more than one likes to see, but they seem necessary, and presently the new names will be just as familiar as the old. It is impossible to pass an opinion off hand upon a work of this kind, for a critic must have all the facts before him before his opinion is worth anything. It is often injustice to a monographer to pass judgment too hastily upon his work, for his opinions are the result of long and patient study, while a flippant criticism is entirely unembarrassed by facts. Therefore, the best test of such a work as that of Professor Bailey is its wearing power. It would be impossible in this brief notice to mention even the principal changes in nomenclature. In this connection the Torrey Botanical Club should be congratulated upon the appearance of this initial number of its proposed series of memoirs. It is a movement in the right direction, and should be encouraged by the hearty support of American botanists.

[1] BAILEY, L. H.—Studies of the types of various species of the genus Carex. Memoirs of the Torr. Bot. Club, Vol. I, No. 1. pp. 85. Issued May 25, 1889. Price $1.00.

Cryptogamic Botany.

Although it is true that "no general handbook to cryptogamic botany has appeared in the English language since the Rev. M. J. Berkeley's, in 1857," as Bennett and Murray remark in the first sentence of the introduction to their new text-book, yet the subject has received good treatment in several general works both by English authors and through translations. A new text-book devoted exclusively to this section of systematic botany must therefore show itself superior to what is already published, in other ways than having a separate binding, in order to be fully acceptable. There is no doubt that the new "Handbook of Cryptogamic Botany" by Bennett & Murray[2] presents the subject in the main in accordance with the latest views and in convenient compass for the use of students. In attempting to cover the whole ground uniformly, the authors have scarcely escaped the tediousness of a bare enumeration of facts. The facts can be relied upon, however, as judiciously collated directly from authoritative sources.

The subject is subdivided as follows: (1) Vascular Cryptogams, (2) Muscineæ, (3) Characeæ, (4) Algæ, (5) Fungi, (6) Mycetozoa, (7) Protophyta, the last including diatoms and bacteria. This is not a classification that a majority of advanced systematists are likely to favor, particularly as to the separation of the algæ and fungi into distinct groups. It is well that the myxomycetes should not masquerade as fungi; but it is difficult to see why the bacteria are not equally entitled to autonomy, instead of being thrust among the protophytes as the only non-chlorophyllous members of that group. If the classification of the thallophytes adopted by the authors is one for convenience, it invites little criticism, but if it is to show relationship, there are as many inconsistencies in it, to say the least, as in that of Sachs, which most later works have adopted.

We can not but think that the authors are unfortunate in their attempts to improve the commonly accepted terminology. Not until botanists make a serious attempt to anglicize such names as geranium, petunia and gladiolus into *gerane*, *petuny* and *gladiol* is it likely that they will adopt *sclerote*, *epiderm* and *antherid* for sclerotium, epidermis and antheridium. But if one is to adopt changes of this kind in order to simplify technical language, why not be consistent and use *prothal* for prothallus and *sore* for sorus? Other considerable changes in accepted usage are the use of the term *sperm* and its combinations for the sexually produced spore, and the restriction of the meaning of reproduction.

Aside from the strictures noted we have only praise for the work. It is an excellent epitome of present knowledge on the subject, with many references to the principal original publications, numerous fine illustrations, and the right kind of paper, typography and binding. Many of the illustrations will be familiar to students of Sachs' and de Bary's works,

[2]BENNETT, ALFRED W., and MURRAY, GEORGE.—A handbook of cryptogamic botany. pp. 473; 378 illustrations. 8vo. London: Longmans, Green & Co., 1889.

and some would appear to belong to the former which are not so accredited.

Physiology of tannin.[3]

Concerning no substance found in such quantity in plants has our knowledge remained so long so defective as in regard to tannin. This is largely due presumably to the rare combination of botanical knowlege with the skill of the analytical chemist. Most botanists who have studied it have used microchemical methods, and most chemists who have given it any attention have paid little heed to its functions or origin in the plant. The unsatisfactory state of our knowledge can be discovered by consulting any, even the most recent, of our text-books. After considerable study with microchemical methods, Dr. Kraus, of Halle, undertook a thorough comparative study of the origin and behavior of tannin, using the most approved methods of the quantitative chemist for determining its presence and amount. These were chiefly the Schröder-Löwenthal method of titration with chamæleon, and Fleck's method of precipitation with neutral cupric acetate, ignition, and weighing as CuO. The former method, while not indicating the total amount present, is nevertheless suitable for comparative studies. Kraus's chief conclusions are as follows:

Tannin is formed in green leaves under conditions which coincide closely, though not exactly, with those of assimilation. Tannin is not, however, a product of assimilation of carbon, for this process can and does go on independently. Tannin once formed does not undergo chemical alterations, but is carried out of the leaves along the veins and petiole to places of storage. In woody twigs it descends chiefly or only in the bark. This descent begins with the unfolding of the leaves and continues late in the growing season. The tannin of germinating rhizomes even though a large portion of their weight (25-40 per cent.) disappears to form the new organs, does not diminish in quantity. On the contrary, it may increase. All the new organs contain tannin, which must therefore be formed in the darkness. Neither in woody plants nor in seeds does tannin behave as a reserve stuff.

After discussing the two modes of formation of tannin indicated above, the author gives an account of its anatomical relations, treating (a) of the transitory tannin, the green tissues in which it is formed, the conducting and storage tissues, and (b) of the autochthonous or resting tannin in growing-points, tannin-sacs, etc. The tannin of galls he calls, provisionally, autochthonous. Chapters on the methods of research and a sketch of previous investigations are followed by the details of his experiments, covering 52 pages.

It strikes us that the author is rather inclined to depreciate or ignore the labors of previous investigators, and that his assumption that he

[3] KRAUS, GREGOR.—Grundlinien zur Physiologie des Gerbstoffs. pp. vi. 131. 8°. Leipzig: W. Engelmann. 1889. M. 3.

starts *de novo* is rather too sweeping. It is true that conclusions founded on microchemical methods are not so well based as those on quantitative determinations. It is also true that when the conclusions of other investigators coincide with his own, Kraus should cite these with due credit, which he too often fails to do. In this work, however, we have a firm point of departure, and with these well sketched "Grundlinien" it is to be hoped that the additions will be rapid until we can have the work with the title, Physiologie des Gerbstoffs.

Minor Notices.

THAT MAGNIFICENT publication, *Die natürlichen Pflanzenfamilien*, has just completed III Teil, 1. Abteilung b, in six parts. It contains Phytolaccaceæ, and Nyctaginaceæ by A. Heimerl, and Aizoaceæ, Portulacaceæ, and Caryophyllaceæ by F. Pax. The chief changes among North American Nyctaginaceæ are that Oxybaphus is included under Mirabilis, and Pentacrophys under Acleisanthes. The name Aizoaceæ may sound strange, but it stands for our Ficoideæ. Our genera of Portulacaceæ stand as usual, but in Caryophyllaceæ the changes are numerous and radical. In the first place, the Illebraceæ are brought back. Lychnis seems to disappear from our native flora, our species being divided among Agrostemma, Melandryum, Viscaria, etc. For instance, *Lychnis Githago* Lam. becomes *Agrostemma Githago* L., *L. apetala* L. is *Melandryum apetalum* Fenzl., and *L. alpina* L. is *Viscaria alpina* Fr. What becomes of all of them is hard to find out. Mœhringia is restored to generic rank, and another Arenaria, *A. physodes* DC., becomes *Merckia physodes* Fisch. *Tissa* Adans. replaces Lepigonum or Spergularia, as followed by Dr. Britton in *Bulletin of Torr. Club* (May). It will be a task interesting to some of our botanists now to reconstruct our specific names on this new basis.

A REVISION of North American Rhamnaceæ has just been published by Dr. Wm. Trelease, being a reprint from the *Trans. St. Louis Acad. Sci.*, Vol. V, No. 3. The order contains 12 North American genera, and the following changes from Watson's Bibl. Index are noted: Scutia disappears, *S. ferrea* Brogn., becoming *Condalia ferrea* Griseb.; *C. Mexicana* Schl. is added from Arizona; *Reynosia latifolia* Griseb. is added from S. Florida; *Rhamnus Insulus* Kellogg, is included under *R. crocea* Nutt.; *Sageretia Wrightii* Watson is added from New Mexico and Texas; *Colubrina reclinata* Brogn, is added from S. Florida.

VOLUME I., Part 6, of *Pittonia* (March–May, 1889), has an interesting table of contents. This part completes the volume, which is suitably indexed. The amount of botanical work represented by this first volume may be inferred when it is known to contain 6 new genera, 180 new species, and 3 new varieties. This does not include the numerous transferred species. The present part contains the following papers: Vege-

tation of the San Benito islands; Supplementary list of Cedros island plants; Concerning some Californian Umbelliferæ; Botanical nomenclature in N. Am.; Baron Mueller on early binomials; New or noteworthy species, IV; Plants from the bay of San Bartolomé; Analogies and affinities, I; New or noteworthy species, V; Reminiscences of Major J. E. LeConte. All these papers are from the pen of Professor Greene, excepting the last, which is by Mary Graham.

ANOTHER CONTRIBUTION to local botany comes to us in the list of the flora of Lorain county, Ohio.[4] It is a bare list, without notes on distribution, locality or abundance, omissions which are explained by the designation "preliminary." It is well printed, in such a way as to leave space for the notes which will need to be inserted as the data for a complete catalogue are obtained, and is accompanied by an excellent detailed map of the county. The nomenclature conforms to that of the revised Manual which is soon to appear.

NOTES AND NEWS.

TORREYA CALIFORNICA is figured in *Gardener's Chronicle* of June 29.

EDWARD GILLETT, Southwick, Mass., desires a large number of the roots of Dodecatheon Meadia.

MR. H. H. RUSBY has been appointed Professor of Botany and Materia Medica in the New York College of Pharmacy.

MR. T. S. BRANDEGEE, a well-known western botanist, has been married to Mrs. Mary Curran, the botanical curator of the California Academy of Science.

A BEAUTIFUL mountain meadow on Mount Rainier, covered with Erigeron salsuginosus in bloom, is reproduced in *Garden and Forest* (July 3) from a photograph.

REV. THOMAS MORONG, now traveling in the Argentine Republic, has written a short series of articles for *The Standard* of Buenos Ayres, on the Paraguayan flora, chiefly with reference to forage plants.

A HYBRID Catalpa is described and figured in *Garden and Forest* (June 26) by Professor Sargent. It is thought to be a hybrid from C. Kæmpferi, the Japanese species, and one of the American species, C. bignonioides or C. speciosa, probably the former.

THE GOLD MEDAL of the Linnæan Society has been awarded this year to Professor Alphonse DeCandolle, in recognition of his important services to botany. The gift was received by his grandson, a fourth representative of a very distinguished line of botanists.

[4] WRIGHT, ALBERT A.—Preliminary List of the flowering and fern-plants of Lorain county, Ohio. Map. 8°. Oberlin, O.: E. J. Goodrich. 1889.

PROFESSOR EDWARD L. GREENE has been botanizing during June and July in California, Arizona, Colorado, Wyoming and Idaho. The first part of August is to be given to Montana, and the last of the month to Washington.

CLAYTONIA CHAMISSONIS Esch. has been found in abundance in Minnesota by Prof. John M. Holzinger. It is described as growing in a wooded ravine west of Queen's Bluff, about twenty miles below Winona. The occurrence of this western mountain species so far east is an interesting discovery.

HOW SHOULD the names of the classes and orders of the Linnean sexual system be pronounced? Prof. Th. Fries says that, as this is a vexed question, it is of interest to know that Linnæus and his pupils accented the penult (Monandría, Didynamía, Monogynía, etc.), and that this practice continued in Sweden until the last decade.

ANOTHER plant disease, the third surely attributable to the attack of bacteria, is described by M. Ed. Prillieux in the *Revue generale de Botanique* for June (p. 293). The disease appears on the twigs and larger branches of the olive and Aleppo pine in the form of tumors of varying size. The disease seriously affects the cultivation of the former tree.

PROF. C. S. SARGENT begins in the number of *Garden and Forest* for July 17 a series of papers entitled "Notes upon some North American Trees," in which he discusses points of nomenclature and offers other critical remarks on these plants. This series, as well as much else of the contents of this journal, will be found of value to systematic botanists.

AN INTERESTING fossil plant from the Upper Devonian of Wyoming county, Penn., is described and figured by Sir Wm. Dawson in *Am. Jour. Sci.* (July). It combines the fructification of the *Cordaiteæ* with the somewhat netted veined leaves of *Nœggerathia*, thus connecting two groups of paleozoic plants. It is by such discoveries that paleobotanists hope to read the riddle of the palæozoic flora.

THE RECENT BULLETINS from the Agricultural Experiment Stations are as follows: *Illinois*, Grasses and Clovers, effect of ripeness on yield and composition, Thomas F. Hunt; *Iowa*, Sorghum, G. E. Patrick; *Kansas*, Sorghum blight, Hackberry knot, Cross-fertilization of corn, Germination of weed seeds, W. A. Kellerman and W. T. Swingle; *Michigan*, Chemical composition of cornstalks, hay and screenings, R. C. Kedzie.

F. GRAVET notes (*Revue Bryologique*) that the red and yellow hues of the leaves of the Sphagna appear only when the plants grow in exposed places where they receive direct sunlight, and that these colors are due to the presence of tannin, as shown by microchemical tests with sulphate of iron and bichromate of potassium. In a very puzzling way, however, the same colors under the reagents appear in the male branches and capsules of green-leaved forms.

In some "remarks on the color reactions and the aldehyde nature of wood,"[1] Dr. Emil Nickel contends that the reactions of anilin sulphate, phloroglucin, etc., are not due to the vanillin in the lignified walls, as has long been believed, but that the woody wall itself reacts to these substances as do the aromatic aldehydes and allied bodies. He has shown that vanillin does not approach wood in sensitiveness to the "lignin reagents." Investigations in this direction may shed light on the obscure nature of "lignification."

E. R. Trautvetter has willed his herbarium, which is exceedingly rich in Russian plants, to the Herbarium of the Royal Botanic Garden at St. Petersburg. This is most fitting, for it puts these plants in the place where they will be of the most benefit to those who will need them most. It is in striking contrast with the disposition which the late H. G. Reichenbach made of his collection of Orchids, and which all botanists unite in condemning. Reichenbach has been for years the most indefatigable student of this group, and has described a great many new species, whose types are chiefly confined to his own collection. By the terms of his will this collection goes to the Imperial Hof-Museum at Vienna, where it is to be *kept sealed for twenty-five years!*

The gigantic Sumatran Aroid, discovered by Dr. Beccari in 1878, and transplanted to Kew Garden, has at last concluded to bloom. It is a veritable Titan, bearing the name *Amorphophallus Titanum* Beccari. The tuber is 5 feet in circumference; the solitary leaf stalk 10 feet high; the leaf 45 feet in circumference; the scape 19 inches high; the spathe 3 feet in diameter; and the spadix nearly 6 feet long. The smell from this huge inflorescence is almost overpowering, but lasts only about two days. It is said to be like that of "rotten fish, but of an intensity unspeakable." The plant was at its best for so short a time, that all the study arranged for could not be carried out, but the monster is now fairly well known so far as its outward appearance goes.

Kny's recent researches on the formation of periderm in tubers over the surface of wounds have led him to the following conclusions: 1. The cell-divisions which produce the periderm cells proceed most rapidly in an atmosphere of medium humidity. 2. In chlorophyll-free tubers light does not influence them. 3. Tubers which were kept for twenty-five days previous to the experiment at a temperature of 6–7°C. formed periderm more slowly than similar ones which were kept for the same time at a temperature of 18–21°C. 4. The position of the wound has no influence. 5. Free oxygen is necessary not only for the beginning of the cell-divisions, but also for the suberization of the membranes. In these experiments the tubers of Solanum, Inula, Gloxinia, Begonia, Dahlia, Gladiolus, Maranta, Tradescantia and other genera were used.[2]

[1] Bot. Centralblatt, xxxviii. 753.
[2] See Berichte d. D. bot. Gessells. vii. 154.

THE AMERICAN ASSOCIATION meets in Toronto August 27. The Botanical Club will hold a meeting on the same day in the room of Section F, University Buildings. The President of the club is Prof. T. J. Burrill, Champaign, Ill. Communications should be sent to the Secretary, Douglas H. Campbell, 91 Alfred street, Detroit, Mich. The Vice-President of Section F is Dr. George L. Goodale. A large attendance of botanists is expected, and no pleasanter place of meeting than Toronto can be found.

THE WILL of the late Professor Reichenbach is about the most astonishing thing in botanical history. It seals up an enormous amount of orchid material that the botanical fraternity had a right to expect would be open for study. The herbarium and library go to the Imperial Hof Museum in Vienna, "under the condition that the preserved orchids and drawings of orchids shall not be exhibited before twenty-five years from the date of my death have elapsed." This is "in order that the inevitable destruction of the costly collection, resulting from the present craze for orchids, may be avoided." The Imperial Hof Museum has accepted the trust.

A "NATIONAL FLOWER" seems to be wanted, something to stir up our patriotic feeling like the flag and the eagle. The public press has gone to work in a cold-blooded way to put the thing to a popular vote, with very small chance of being decided. A national flower must come from the accident of some association, or it will never arouse the feeblest emotion. About the best suggestion from the artistic standpoint comes from M. G. VanRensselaer in *Garden and Forest* (July 10), who favors the mountain laurel (Kalmia), and argues for it well. If utility, along with beauty, can be taken into the count, what more characteristic and widely known American plant than Indian corn? It can be "conventionalized" to heart's content, and furnishes both food and drink—to many.

PROF. JOSEPH BORNMUELLER, director of the Botanical Garden at Belgrade, Servia, has started for a twelve months journey through Asia Minor. Beginning at Amasia, he will travel through the country between the course of the Kisil Irmak, Euphrates, south to the completely unexplored Mountains Ak-dagh. This territory has only once been explored, thirty-five years ago, by the Russian botanist, Wiedemann, and not diligently by any means. Prof. Bornmueller is a young and very successful explorer, with a great deal of experience, especially from his long journey in 1886, through Dalmatia, Montenegro, Greece, Turkey, East Bulgaria and Asia Minor. His original collection will be transferred to Weimar, where Prof. Haussknecht will devote his time to the scientific sorting of the specimens. The latter will be prepared in the most careful manner, and he will be able to accept a few more orders for duplicates. Museums, herbariums, or private persons, desiring a collection are asked to address themselves to George Hansen, Agr. Exp. Station, Jackson, Amador county, California.

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The Uredo-stage of Gymnosporangium.

H. M. RICHARDS.

(WITH PLATE XVII.)

In the *Botanische Zeitung* for June 22, 1888, there appeared a paper by Kienitz-Gerloff entitled, "Die Gonidien von Gymnosporangium clavariæforme," in which he describes the presence of two forms of spores in the gelatinous fruit mass of that fungus. Although both are two-celled and of about the same size, they may, he says, be easily distinguished. Those found on the inside of the spore mass are symmetrical, having thin hyaline walls and finely granular contents, while on the other hand the spores more generally present on the outside are not symmetrical, the upper cell being much blunter than the lower one. Their walls are dark brown and more than twice as thick as those of the first form, and their contents are not granular. It is in their method of germination, however, that he sees the most important distinction. The thick-walled spores always send out promycelia of the form which is characteristic of teleutospores. In the thin-walled spores it is entirely different. In these he observed two cases where the end of the spore grew out in a tube, the contents of which did not divide up into cells and bear sporidia, but remained unbroken, resembling in this the method of germination characteristic of uredospores. He also noticed a singular fact, that, instead of the endospore penetrating the exospore as is usual, the whole end of the spore grew out without rupturing the exospore.

From their general dissimilarity in shape and structure, and from their peculiar method of germination, he concludes that these thin-walled spores represent the hitherto unknown uredosporic form of G. clavariæforme. Were their morphological characters and the method of germination constant, it would be quite possible that the thin-walled spores might represent what he claims. As the uredosporic form has not before been recognized in any of the Gymnosporangia, it seems highly desirable that the view advanced by Kienitz-Gerloff should be tested by an examination of American spec-

imens. That there are two forms of spores in G. clavariæforme and also in other species has been known for a long time. Among the more important references are those of Oersted,[1] who figures both kinds of spores in the case of *G. clavariæforme*, of Rees,[2] in *G. fuscum* and *G. conicum*, of Körnicke,[3] and also of Farlow,[4] and further search would doubtless show other references. Although, as I have just said, the existence of two forms of spores was well known to writers before Kienitz-Gerloff, no particular significance was attached to the fact and they were both considered as forms of teleutospore produced by difference in exposure or time of development.

That the conditions of my work might be as nearly as possible like those of Kienitz-Gerloff, and the results readily compared with his, I took G. clavariæforme, the species used by him in his investigation. As it is quite common on the Juniperus communis in the neighborhood of Boston, I had no difficulty in getting all the material I wanted. That which I used was obtained from Saugus through the kindness of Mr. Seymour. It was collected on the 11th of April, and being at that time still young the spore masses had scarcely appeared on the bark of the Juniper, but it was easily ripened when kept for a short time under a bell-glass in a moist atmosphere. At the time the first observations were made the young spore-masses were only slightly convex and had not swelled to the conical form attained at maturity. At this stage sections across the spore-mass show that all the spores resemble each other closely, being long and fusiform, and no distinction can be made between the blunt thick-walled and the acute thin-walled spores.

When mature differences in the spores are seen. One kind, which is found in the inner portion of the spore-mass, is composed of two acutely conical cells which are joined at their bases, making a long, symmetrical, fusiform, or lanceolate spore (fig. 1); the other is commonly met with nearer to the periphery and consists, like the first, of two cells, but is not symmetrical, the upper cell being quite blunt and rounded off, thus making the spore clavate in form (fig. 2), as is described by Kienitz-Gerloff. Both forms are of about the same size; the clavate variety being perhaps a little shorter in proportion to its width than the other; and both

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1Bull. Acad. Roy. Sci. Copenhagen, 1867, Plates III and IV, figs. 3 and 7.

2Die Rostpilzformen der deutschen Coniferen, pp. 17 and 26, 1869.

3Hedwigia, xvi. 27, 1877.

4The Gymnosporangia of the U. S., 1880.

have long pedicels which are quite distinct when young, but which tend to gelatinize on the edges as they grow older, especially in the case of the fusiform spores. The thickness of the wall averages about the same in all the spores with the exception of those on the very outside. There it is usually somewhat thicker than in the others (fig. 3) and generally of a smoky-brown color. The contents are alike in both varieties, and in no way different from those of the normal *Gymnosporangium* teleutospore, consisting chiefly of a more or less granular mass, in which may be one or more orange oil-like globules and a number of vacuoles. Neither the shape nor distribution of the spores above described is definitely marked, one form gradually passing into the other, with all gradations from the most symmetrically acute variety to the more irregular obtuse one.

In order to see if, as Kienitz-Gerloff maintained, the acute spores germinated differently from the obtuse ones, I took a considerable number of both forms and studied their method of germination under like conditions.

When removed to a glass slide and kept moist with a little water, in a few hours the spores, whether acute or obtuse, produced in the region of the septum from one to three—occasionally four—promycelia of the form typical in this genus, that is, composed of short cells which produce short sterigmata-bearing sporidia (fig. 4). In some cases the sterigmata grew out to an indefinite and often considerable length without producing sporidia. If supplied abundantly with water it not unfrequently happened that, instead of ordinary promycelia, the germinal tubes grew out to a great length (fig. 5), fifteen or sixteen times the length of the spore, and the contents did not divide up, but remained continuous throughout without producing sporidia. When the spores are kept only slightly damp another peculiarity may be noticed. Instead of growing out into promycelia the germinal tubes push out a little distance into short thick filaments and then divide into four or five stout oblong cells which soon fall apart (fig. 6). Subsequently the cells which have become thus separated grow out at one or more of the angles into hyphæ. An appearance resembling such as has been described has also been noticed by Cramer[5] in the case of *G. fuscum*. The process may be still further simplified. In some cases the germinal tubes protrude a very short distance, not producing promycelia or a filament of any kind, but only

[5]Oeber den Gitterrost der Birnbaunil, etc., Schweiz, landwirth Zeit, 1876.

small bud-like cells as is seen in fig 7. Very soon these buds become separated from the spore, and after a time send out tubes, like those which come from the sporidia when they germinate. This method is seldom found among the spores on the outside, but occurs chiefly in those in the inner part of the spore-mass.

In the forms of germination already considered, it will be seen from the accompanying figures and descriptions that the promycelia arose from the region of the septum in all cases, no matter whether the spore was obtuse or acute, or, in other words, whether it was what Kienitz-Gerloff calls a teleutospore or a uredospore. We come now to other forms of germination, where the germinal tube arises from the apex of the spore instead of from the region of the septum. This method of germination was found beyond a doubt in both the acute and obtuse forms, though more frequently in the latter. In fig. 8 a spore which is clearly of the acute form is represented germinating by the end, while in fig. 9 one of the obtuse kind is shown behaving in a similar manner. This form of germination of the obtuse spores was apparently not seen by Kienitz-Gerloff. In some cases where germinal tubes were produced from the end of the spore promycelia were also found arising from the region of the septum.

The terminal promycelia grew in all respects like the others, and, with few exceptions, they all bore sporidia. No cases were seen where the germinal tubes grew out to any very great length even when the spores had been kept in an excess of water. In one case, where the spores were only kept damp, a terminal promycelium was noticed, which broke up in the same way as those arising from the septum under similar conditions (fig. 10). On two occasions germinal tubes were seen to arise from the fixed end of the spore, very near the point of attachment of the pedicel, but, except for their point of origin, the promycelia were normal.

If we now compare the results of my observations with those of Kienitz-Gerloff, it will be seen that the latter are not sufficient to warrant the conclusions which he drew from them. From both his observations and my own it is plain that the obtuse spores borne on the outside of the spore-masses are teleutospores, since, on germinating, they produce the characteristic promycelia. Apparently Kienitz-Gerloff is of the opinion that the promycelia are always produced at the septum. I have shown, however, that, although

this is the rule, it is not unusual to find the promycelia produced at the apex of the spore. Furthermore, the statement that the obtuse spores are teleutospores is not invalidated by the fact that under certain conditions the germinal tubes do not form the ordinary promycelia with sporidia, but break up into separate cells or even drop away from the spore in the shape of bud-like cells before they have developed into a filament of any kind. With regard to the fusiform spores Kienitz-Gerloff's statement is that they bear germinal tubes, which, in growing out into filaments, do not form proper promycelia with sporidia. But my observations, although they agree with those of Kienitz-Gerloff in showing that terminal germinations are occasionally to be found in the fusiform spores, yet, in the majority of cases, they germinate like the obtuse spores and bear normal promycelia and sporidia at the septum.

Since then it is the fact, as shown by these notes and the accompanying figures, that, in their mode of germination, both the obtuse and fusiform spores bear the promycelia characteristic of teleutospores, we must conclude that, if the obtuse spores are teleutospores, the fusiform spores are also teleutospores. The only ground for supposing that the latter are uredespores is the statement of Kienitz-Gerloff that they do not produce promycelia but rather the tubes found in uredosporic germination, and I have shown that this statement is erroneous, and that what he considers to be the constant form of germination in the case of the fusiform spores is really only an exceptional form of germination, which is also to be seen at times in the obtuse spores with regard to whose teleutosporic nature all writers agree. We must conclude that both the obtuse and fusiform spores are teleutospores in spite of their differences in size and shape. As already remarked G. clavariæforme is not the only species in which two forms of teleutospores are known, and for further information on this point one should consult the paper by Dietel in Hedwigia, 1889, p. 99. The mode of germination of teleutospores of Gymnosporangia is subject to a good many modifications, depending, in part at least, on the variations in the amount of moisture to which they are subjected. The modifications mentioned above, as I am informed by Prof. Farlow, at whose suggestion I undertook the examination of the subject, have been frequently seen by those who have studied this genus, although but little has been said about them in print.

EXPLANATION OF PLATE XVII.—Fig. 1. Typical fusiform spore.

Fig. 2. Typical clavate spore.

Fig. 3. Thick-walled clavate spore of the form found on very outside of the spore mass.

Fig. 4. Showing normal method of germination.

Fig. 5. Method of germination of spores in an excess of water.

Fig. 6. Method of germination of spores when damp.

Fig. 7. Simplified method of same.

Fig. 8. Fusiform spore germinating by the end.

Fig. 9. Clavate spore germinating in a similar manner.

Fig. 10. Terminal germination brought about by same conditions as in 6 and 7.

All these figures are magnified 410 diam. and then reduced one-third, except Fig. 5, which is magnified 250 diam.

Cryptogamic Laboratory of Harvard University.

Observations on the temperature of trees.

H. L. RUSSELL.

(WITH PLATE XVIII.)

During the winter and spring of 1889 experiments were conducted upon the temperatures of trees, and the following preliminary notice of some of the results obtained is given. A number of questions have arisen in the course of the experiments which will require some time to solve, and as these will have to be postponed till the next winter, it is thought best to lay the facts gained so far before those interested in these problems, and reserve the remainder for further consideration. As far as could be ascertained very few data have been collected upon the subject, and the observations are recorded, as they may possibly be of use in the future.

The experiments were conducted in the following manner: Holes one-half inch in diameter were bored into the trees at equal heights from the ground. The thermometers used were Centigrade, and were carefully compared with each other to detect any variation in graduation. The thermometers were inserted in the borings so that the base of the bulb came in contact with the wood; the space about the thermometer being packed tightly with cotton-wool.

An experiment was made upon a good-sized shag-bark hickory (Carya alba) to see to what extent the temperature of the interior of the tree followed that of the exterior. The tree was about 30 cm. in diameter, and the borings, which were on the south side, were made at the following depths, viz.: 3, 6, 10, and 12 cm. Readings were taken from the thermometers at these varying depths, and also from one placed on the north side of the tree, not in contact with the bark or exposed to the direct rays of the sun. These readings were noted at intervals of 1 to 2 hours during the day, and in a number of instances were continued through the night. The period of time embraced by the experiment was about fifteen days, and covered several days of warm weather as well as our coldest days.

The detailed readings are not given here, but the results arrived at are essentially as follows. The temperature of the tree as a general rule ranged higher than the outside, with two or three exceptions, when the air temperature was higher during the warmer portions of the day. The maximum temperature of the air was generally between 1 and 2 P. M., while the minimum ranged from 6 A. M. to 7. The following table indicates the average time of the maximum and minimum temperatures for the different depths:

	Maximum.	Minimum.
Outside.	1.00 P. M.	6.45 A. M.
3 cm. deep.	2.00 P. M.	7.00 A. M.
6 cm. deep.	4.15 P. M.	8.00 A. M.
10 cm. deep.	6.15 P. M.	9.30 A. M.
12 cm. deep.	6.45 P. M.	10.00 A. M.

It will be seen by reference to this table that the rate of conduction varies somewhat for different depths; that the heat is both absorbed and radiated more rapidly in the outer layers than in the center.

Representing the temperatures graphically, it was seen that that of the interior of the tree presented the most uniform curve, *i. e.*, one whose amplitude was the least. The mean daily variation for the outside and the shallowest boring was about 12.5° C., while that of the interior was only 7° C. Thus the average temperature of the tree, in its most central part, is not much above the temperature of the air during

the winter months. During the cold days in the early part of February, in which the thermometer fell to –22° C., we find that the interior of the tree registered only 5 degrees higher than this.

To see if there was any material difference between conifers and deciduous trees, an experiment was made with a Scotch pine (Pinus sylvestris), and a white oak (Quercus alba). The trees selected were of nearly the same diameter, and all other factors were considered, to equalize, as far as possible, the conditions of the experiment. By reference to A, plate xviii, it will be seen that in no case (where conditions were favorable for the experiment) was the temperature of the pine as high as that of the oak, with the exception of the early observations in the day. As a general rule, the observations from 7 to 10 A. M. indicated a higher temperature in the pine than in the oak. This is due to the slower radiation of the pine. It is noticeable that the temperature of the oak falls more rapidly than the pine, late in the afternoon, showing that it radiates the heat absorbed during the warmer portions of the day quicker than the pine, which is clothed with evergreen foliage.

Prof. Prentiss states that conifers have a higher specific heat than deciduous trees in winter.[1] He uses the term specific heat, not in its physical sense, but as meaning the heat evolved by metabolic processes. From the observations made here we have been unable to arrive at similar results. The temperature of the pine we found to be lower than that of the oak at all times except during the latter part of the night and early morning, and the chemical changes occurring in the stem at this season of the year are probably so slight that radiation would carry off the heat about as fast as it was produced. The period of observation for this experiment extended over the middle of March, with the temperature ranging high for this season of the year, but as yet little or no change had taken place in the interior structure of the tree. To see if heat evolved by chemical changes in the tree would be sensible to a thermometer, a comparison was instituted later in April between dead and live timber. The tree selected was a very favorable one for the experiment, inasmuch as it had one large dead branch, with bark intact, while the remaining branch was a vigorous growth. This apple tree was taken for the experiment at a time when the buds were quite well started, so that chemical

[1] 2d Rept. Cornell Univ. Exp. Stat. ('82 and '83), page 42.

action was going on vigorously at the time. The experiment was continued for ten days, but without any very definite results. The maximum of temperature alternated rather irregularly between the live and dead wood, and did not seem to give any uniform results. The causes of these rapid fluctuations are not so easy to understand, yet I think that it is extremely doubtful whether the metabolic processes involved generate sufficient heat to influence the ordinary thermometer.

We have seen above that considerable difference was found between evergreens and deciduous trees like the oak. To see if this same difference was apparent between evergreen and deciduous conifers, an experiment was tried with the pine (Pinus sylvestris) and the European larch (Larix Europæa). The results obtained are shown in B, plate xviii. They indicate that the temperature of the larch and oak were very nearly the same. As a general rule the temperature of the larch was above the pine during the greater part of the day, the reverse being true for the night and early morning. There is not any very great difference in the structure of the wood of the larch and pine, so that this difference can not be attributable to this cause. It seems to lie in some other direction.

Comparative observations were made with the pine, larch, oak, poplar, and outside air, and in all cases the temperature of the pine was found to be considerably lower than any of the remainder, with the exception mentioned. To what, then, is this lower temperature due? Presumably the thick coating of foliage on the pine exerts a considerable influence upon it, as it would seem to have a tendency to prevent absorption of heat by the trunk, and would very likely interfere with radiation to some extent.

In order to see what influence the foliage had upon the temperature of the trunk, the following experiment was made: Two balsam firs (Abies balsamea) were chosen, that were as nearly like each other as possible, and the temperatures of their trunks were compared with each other for a time, to see if any material difference existed between the individual trees. The foliage of this tree presents a compact surface, and was thus better adapted for the experiment than the pine. After a short period of comparison between the two trees, one of them was stripped of its foliage for a distance of several feet above the thermometer, and comparative readings were then taken, to see what influence denudation of foliage exerted upon the temperature of the trunk.

In C^1, C^2, Plate xviii, *a* represents the fir which was later stripped of its branches; *b* the one that was used for a control experiment. The slight difference between *a* and *b* in C^1 may be attributable to the more exposed position of *a*, and also to the less compact condition of the lower branches. C^2 shows the temperatures of the two trunks after the branches had been removed from *a*. It will be seen that the greatest variation before stripping was only about 1° C. (see C^1), while there was often a variation of 4–5° between them after the branches had been removed from *a*. It is also noticeable that the temperature of the stripped tree begins to fall more rapidly, and that as a rule it was lower than *b* in the morning. These results point quite conclusively to the fact that the thick coating of foliage which surrounds the trunk accounts, to a large extent, for the lower temperature of evergreen conifers, and that absorption and radiation go on at a much more rapid rate where trees are not provided with winter foliage.

To see if any material difference existed between the temperatures of woods of different densities, an experiment was first made between a shag-bark hickory (Carya alba) and a cultivated crab-apple tree. The hickory was somewhat the larger of the two trees. The specific gravities of the trees show a difference of .1324, the hickory being 0.8372, and the Pyrus 0.7048.[2] The borings were made to a depth of 10 cm., and readings were taken for a period of about ten days, but no very great difference was recorded in the temperatures. It may be noted in this connection that there was no very great difference in the character of the bark, as the bark of the hickory had not begun to exfoliate very much. Another trial was made with a poplar (Populus grandidentata) and a white oak (Quercus alba). Here the difference in density is much more marked, the specific gravity of the poplar being .4632, while that of the oak is .747, a difference of over 50 per cent.[2] The borings in this case were not made so deep, in order to see how great a difference existed in the outer layers of the wood proper. The course of these temperatures, as drawn in diagram D, plate xviii, shows that the soft wood was far more variable than the denser wood. Not only was the temperature of the poplars considerably higher during the warm part of the day, but it sank from 1–2° below that of the Quercus during the night. The range in variation of the poplar averaging about 16.5° C. per day, while

[2]Report Tenth Census. Sargent: Forest Trees of N. A.

that of the oak was 12.5°. The temperature of the oak remained about the same as the air temperature, while the poplar was often 5° higher during the heat of the day.

The question naturally arises, what causes the difference in temperature between these trees? Does it exist in the different densities of the two woods, or can it be assigned to some other cause? There are several sources to which we might look to find the cause. The different densities of the woods, the heat evolved by chemical changes in the tree, the color and texture of the bark, causing different degrees of absorption, might be suggested as possible causes. It is more than likely that more than one of these possible causes are involved.

If we compare the temperature of the larch and oak, we find that although quite a difference exists between their specific gravities, but little difference is found in their temperatures. The difference in their specific gravities is .1234 or about 20 per cent., while the difference in the mean daily temperature for the length of the experiment does not exceed $\frac{3}{4}$° C. This evidently does not furnish a satisfactory reason for the difference in temperature. The difference in the absorptive powers of different colors is well known, but here I think it plays but a small part. The poplar used for the experiment was covered with a smooth greenish-gray bark, while in the oak the bark was roughened and darker gray in color. The darker the color, the greater the amount of heat absorbed, would lead one to think that the temperature of the oak ought to be higher than the poplar, but such was not the case, so that we must seek still farther for a cause.

Heat due to chemical changes, if sensible to the thermometer, might produce some difference, as the metabolism of the poplar was probably greater at this time than in the oak. But from the experiment conducted upon living and dead timber with the apple tree, it is hardly possible that this would account for the considerable difference that existed between these two trees. The influence of the bark upon absorption plays, I think, a far more important part than either of the above. It was seen that the oak and the larch differed but little in respect to temperature, and here we find quite a similarity in the texture and character of the bark. Both are of a neutral gray tint and are more or less roughened, although scarcely corrugated. To test the influence of the bark upon the temperature, two trees were taken of the same species (Populus grandidentata), but with bark of different character.

One of the trees had a close, smooth bark, and the other a thicker, rough, corrugated bark. There was considerable difference in the diameter of the two trees, the smooth one being about 16 cm., and the rough one about 28 cm. in diameter. To eliminate the influence of this difference in volume as much as possible, the borings were made on the south side of the tree to the depth of 6 cm. Reference to diagram E will show the temperatures of the two trees. *a* indicates the rough barked, and *b* the smooth barked poplar. On some days there was a difference of 6 to 10 degrees in the temperatures, the smooth barked tree being the warmer. It was noticeable that on cloudy days, as were the 17th and 18th, that the variation was not so marked. Although the larger volume of *a* would have a tendency to lower its temperature, yet it hardly seems possible that anything like this difference would be caused on this account.

Lack of time at present, prevented further experiments being made upon this point, but the above results point, I think, toward the conclusion, even if they do not warrant us in stating positively that the direct absorption of heat is the main cause of the higher temperature of trees, and that it is largely dependent upon the character of bark.

Botanical Laboratory, Univ. of Wisconsin.

EXPLANATION OF PLATE XVIII.—Vertical scale 1° C.=.1 inch. Horizontal scale, 12 hrs.=.6 inch. A, Showing difference in temperature between evergreen and deciduous trees. B, Showing difference in temperature between evergreen and deciduous conifers. (Period from 16th to 19th indicates continuous rainy weather.) C, Influence of denudation of foliage upon temperature of conifers. C^1, Before stripping off foliage from tree. C^2, After stripping off foliage from tree; *a*=tree that was stripped; *b*=tree used for control experiment. D, Showing difference in temperature between woods of different densities compared with temperature of the air. E, Showing difference in temperature between two trees of the same species, with bark of different nature.

Paraguay and its flora. I.

THOMAS MORONG.

Land of heat probably most people in the Northern United States would say, if they thought of it at all. True enough, for the mercury in the Fahrenheit thermometer hanging in

my room averaged from November 1 to the middle of April 80° night and day, and sometimes rose to nearly 100°, while in the sun out of doors it easily marked 110°. Even now (July) in the month corresponding to our January, it stands much of the time at 65° and 68°, and has only occasionally fallen as low as 40°. Land that rarely knows a slight frost, in which stoves are nearly unknown, where the windows are generally without glass, where the country people sleep and almost literally live out of doors; land of the most delicious atmosphere to one who likes warmth as well as I do; where rheumatism, neuralgia, consumption and their kindred diseases seldom occur; land that for these very reasons possesses a rich and varied vegetation, it is necessarily a land full of surprises and of rare interest to a botanist from a colder climate. Around him, with trunks tall and straight as a column, and with their graceful, drooping fronds rustling in the slightest breeze, stand several species of that monarch of the floral world, the palm. The most common species about Asuncion, popularly called the "Coco" or "Pindo," is the Cocos australis, which rises to the height of thirty or forty feet. This tree bears a true cocoa-nut, about the size of a marble, an inch and a half in diameter. I could hardly believe it to be a cocoa-nut until I split one of the fruits in two and ate the contents. The meat is as good as that of its larger brothers for aught that I can see. It yields an excellent oil, and is often here ground and pressed in mills for that purpose. The foliage furnishes a very good fodder for cattle, and is occasionally used for thatching roofs. No boys, however, would venture to climb the tree in order to get the fruit, for the trunk is armed over its whole length with long, sharp thorns, some of them at least five inches in length, wounds from which are said to fester in the flesh. Two other species of the palm are common in Paraguay, the Cocos sclerocarpa, similar to the Pindo, but with a smooth trunk, and a smaller-sized tree which has nearly erect, fan-shaped leaves, and bears a large panicle of small berries (Livistona?). Across the river Paraguay, in the territory known as the "Gran Chaco," another and a very different species, known as the "Palma negra" (*Copernicia cerifera* Mart.) is very abundant. Its wood is exceedingly hard and durable, and much used for building purposes. The fruit of this palm is a large cluster of one-seeded berries, and its long roots furnish Carnauba, a well-known drug of commerce.

Another thing in this vicinity which reminds one that he is

within the tropics is the castor oil bean (*Ricinus communis* L.) which grows most vigorously in waste ground, often attaining a height of twenty or twenty-five feet, and producing an abundance of beans. "Castoria" is not to be found in the drug stores notwithstanding. From their utter neglect of this plant, I infer that the Paraguayans do not appreciate the virtues of castor oil. Even the Guarani women, who are great "herb doctors," pass the Ricinus by.

Perhaps, however, the thing which has interested me the most is a plant belonging to my own particular line of study. Few naturalists of North America or Europe can boast of having visited and gathered the Victoria regia in its native home, but that has been the good fortune of your correspondent, for it is quite common in the lagoons of the Paraguay river. To my eye, however, the flowers, although gigantic, have not half the loveliness and none of the delicious fragrance of our aquatic queen, the Castalia odorata. Their very immensity mars their beauty, and what is worse, in the estimation of the collector, the lower part of the calyx and the pedicel are covered with spines, which makes its collection a work of some difficulty. The pads of this monstrous water lily might well serve as a child's boat, for they are often as much as three feet in diameter, with an erect edge some two inches in height. Once, when gathering specimens, I thought I would test the buoyant capacity of the leaves. With much labor, I waded out into the lagoon, and, at considerable risk of a ducking, succeeded in placing a foot upon each of two adjoining leaves. They supported my weight with ease, sinking a few inches only, but not sufficiently to allow the water to run over the rims. So it is entirely within bounds to say that the pads are able to bear a weight of fifty pounds without difficulty.

Cacti are not numerous in this region, though several species occur. One of them is an Opuntia, similar in flower to my old Nantucket friend, Opuntia vulgaris. It is here called the "Tuna," or Indian fig, and grows as high as one's head, with many spreading branches, and bearing an orange-colored fruit as large as a hen's egg. Two species of Cereus, with beautiful large silvery flowers, are also found. One of these, which has a thick trunk protected by many rows of formidable spines, is columnar, often attaining a height of twenty feet or more, and sometimes splitting into several upright branches, which remind you of the pictures of the old Roman candelabra. This is occasionally used for making

hedges. Still another form is a genuine tree cactus, or, at least, it has a trunk looking exactly like that of a smooth tree, and throws out limbs from the top in arborescent fashion. It seems to be an Opuntia, as it has the flat lobes and the flowers and fruit of that genus.

I notice a number of Agaves, with towering flower stems from fifteen to twenty feet in height. I know that it is said that the Agave plant dies after flowering once. That may be so with what we call at home the Mexican Agave, which is frequently cultivated here, and which I have not seen in flower, but I am strongly inclined to think that it is not the case with another species which is a native of Paraguay, and plants of which I often see in flower. I am sure that I have seen, more than once, living plants with the withered stalks of last year's flowers upon them. I do not think that I can be mistaken in calling this an Agave, as it has the tall spike and the peculiar flowers and fruit of that genus. However, I do not wish to be dogmatic upon the question, and leave the matter for further investigation.

Yuccas are numerous, some of them quite diminutive and others which thrust their radiating spear-like leaves over an area six or eight feet in diameter, and throw up a flower stalk of equal height. Akin to the Yucca, at all events in general appearance, if in no other point, is a very striking plant which belongs to the Bromeliaceæ (possibly Bromelia Caraguata, as some botanists name it). The native Guarani name of the plant is "Caraguata," and many of the common people, who seem to recognize its affinities intuitively, call it the "wild pine-apple." This has numerous long and stiff dagger-like leaves, with hooked spines on their edges, and in its center a rosette of brilliant scarlet foliage, which can be seen for a long distance. The flowers are white, on a thick caudex, at length producing a huge bunch of fig-like fruit, which remind one, indeed, of the pine-apple, but are by no means sweet and luscious to the taste. The brilliant coloring of the leaves disappears altogether after flowering, and nothing remains of it in the dried specimens. Mr. Ball ("Notes of a Naturalist in South America," p. 210) calls this a plant peculiar to the Chilian flora, but he is mistaken, as it is equally common in Paraguay, and has long been known to the inhabitants as one of the many wild plants which can be used in the manufacture of textile fabrics. The fibers of the leaves, when properly treated, split into fine threads, forming an excellent material for cordage and

cloth. Like the "Chacuar," which is either the same or a similar species that grows in the Chaco australis, its threads have been employed by the Indians from time immemorial for making various articles, such as garments, cords, fishing-nets, baskets, and even coats of mail, which are said to be impenetrable by arrows. Several other species of the same family are found here, all of which can be used for the same purposes. One of these, which I have collected, grows upon ledges of red sandstone, and has a tall scape of flowers with scarlet bracts and calyx and bright blue petals.

Of forest trees it may be said that no pine, oak, ash, hemlock, spruce, hickory or maple is known to occur in Paraguay, but the country produces many interesting and valuable woods. With few exceptions they are very compact and durable, and susceptible of a fine polish, but they are generally too cross-grained, knotty and tough to serve for house-timber. Beams made of them are as heavy and solid as iron. The Quebracho colorado, for instance, which is often used in building railroad bridges, furnishes timbers which will support enormous weights and last for years, but the wood is so hard that it can scarcely be cut with a knife. These woods serve admirably for cabinet work, and especially for the turning-lathe. I have seen beautiful cups, goblets, card baskets, and other ornamental objects turned from them, and for veneering many of them are not surpassed in grain, color, delicate markings, and susceptibility of polish by mahogany, black walnut or birch. Among the handsomest trees which I have met is the "Timbo" (Enterolobium timbosa), which grows sometimes to the height oi seventy-five or a hundred feet, with wide-spread and symmetrical branches, and long, pinnate leaves, forming a very ornamental shade tree. The wood is employed in making boats and canoes, but not otherwise good for much as timber. Half a dozen other species of Enterolobium, all inferior to the Timbo, grow in the Paraguayan forests. Another, but much smaller tree, common in this vicinity, is one of the mulberry family (Broussonetia probably). This has an umbrella-like head of large, drooping, palmate leaves that are smooth and shining above, and silvery woolly beneath, and presents an appearance quite as striking to the eye as the palm. Its flowers are diœcious, both the staminate and pistillate, in long, finger-shaped spikes, densely packed together upon a common cylindrical receptacle.

The best wood for furniture and all kinds of house-finish-

ing is furnished by the tree here called the cedar. It is light, straight-grained and red at the heart like our North American savin. Strangely enough, however, it belongs to the mahogany family (Cedrela Brasiliensis), but, unlike its congener, it is a soft wood comparatively.

Asuncion, Paraguay.

BRIEFER ARTICLES.

Abnormal roses.—Freaks are not rare among roses. In the GAZETTE, Vol. IX, p. 177, W. W. Bailey mentions "a garden rose in which, in the center of the rosette of petals, was a perfect but unopened bud." E. B. Harger, Vol. X, p. 214, notes that "on a common double climbing red rose" appeared "a sprout on which grows a whorl of four bracts subtending a cluster of ordinary petals, giving the appearance of a stem growing through the center of the rose." Further examples in this line of variation may be worth noting. A rose-bush on our campus has for the past five years produced only "single" roses and in scanty quantity. Last year the plant was divided at the roots into six parts and transplanted. Early in June, a little more than a year having passed, there appeared an abundance of dark red, velvety, double roses which challenged the admiration of every passer-by. Many of these roses exhibited a peculiar freak. One-third of the whole number showed variations. On one bush were six or seven with the stems produced through the center of the flower. In one case the stem developed two perfect expanded leaves, two leaf buds and a flower-bud, all immediately above the original rose, which was itself large and beautiful. In another instance the result is a "head" of five unopened flower-buds, each showing calyx, corolla and pistils. Other specimens show one, two, three and four of these "secondary" flowers above the roses proper. The principal flower in each case has its sepals and petals in natural condition; the stamens wanting or appearing as modified petals, while the pistils are entirely replaced by the new stem growth which rises an inch or more above the primary rose.—C. B. ATWELL, *Evanston, Ill.*

Dr. A. B. Ghiesbrecht.[1]—The Mexican journal, *La Naturaleza*, has published a graceful tribute from the pen of a native botanist to the services of a Belgian explorer of the flora of his adopted country. For the career of a traveling naturalist Dr. Ghiesbrecht was well equipped physically and by preliminary studies at the universities of Brussels and Paris. Associated with Linden and Funk in the commission appointed by the Belgian government in 1837 to investigate the botany and zoology of

[1] Vida y Trabajos del Naturalista Belga Augusto B. Ghiesbrecht, Explorador de Mexico, por el Sr. D. José N. Rovirosa.

Mexico, he proved himself a worthy successor to Sessé, Mociño, Cervantes, Humboldt, Bonpland, La Lave, and Lexarza. Braving the hardships and exposures of travel in wild and unhealthy regions, undaunted by shipwreck, robbed and wounded by brigands, involved in the strife and wars of contending factions, he pursued for thirty years the work of collecting plants for the herbaria and gardens of Europe and America. Captivated by the novelties of a tropical flora, his earliest and latest field of research, and apparently his favorite one, was the southeasternmost part of Mexico, comprising the states of Tabasco and Chiapas. But from 1840 to 1855 he devoted himself to the interior and other states, crossing the Gran Cordillera three times from ocean to ocean, traversing the Gran Mesa, and ascending the volcanoes of Colima, Jorullo and Cempoaltepec. The number of plants that he has distributed to herbaria or introduced into cultivation must be immense. Their citations abound in the literature of tropical North American botany. M. DeCandolle refers to a series of exsiccatæ in the possession of Cardinal Haynald, at Colocza, Hungary.

A list is given by Prof. Rovirosa of many notable new species, with which the name of Ghiesbrecht is connected; and to this list might well have been added the remarkable arboreous Scrophulariacea, Ghiesbrechtia grandiflora, which served Dr. Gray as occasion to dedicate a new genus to its discoverer. This tree, known in herbaria only by the originals of description collected in Chiapas, has recently been met with by Baron von Türckheim at Santa Rosa, in the Verapaz highlands of Guatemala.

The memoir concludes with a pleasing account of its subject in his eightieth year at his home in San Christobal Las Casas, where he has resided since 1862: "Retired from the wandering life that he pursued for so many years of the middle part of this century, but still vigorous and active, he occupies himself chiefly wfth horticulture and with doing good to the most helpless class of the community, that he has adopted as his own. His medical services are ever at the call of those that suffer; his moderate means suffice, nevertheless, to bring bread to the door of many a needy one; all his actions reveal to those around him, that he, who has read the great book of Nature, has learned to know the duties that bind him to his fellow men. Proud, then, are the people of Chiapas to have him dwell in their capital, and to call him their countryman, as all of us should do who love the advance of science in Mexico."

The example of such a life is not without influence, and to it in some measure do we doubtless owe the botanical collections now being made by Prof. Rovirosa in these localities.—JOHN DONNELL SMITH.

Indian snuff.—In Lloyd's *Drugs and Medicines* of North America several species of Anemone are described and their properties discussed, but the species mentioned below are not included. It is to be greatly deplored that the welcome quarterly parts of that work are not now issued.

In the Northwest the Indians are familiar with valuable remedies for

many diseases. These remedies are all to be found in the varied flora of that great region. I have been shown recently specimens of "Indian snuff," much used by the Indians of the Rocky Mountain regions for nasal and related forms of catarrh. Two plants here go by the appellation of "Indian snuff." One is Anemone cylindrica and the other is Anemone multifida. The leaves of the plants are the part used. These are gathered before the seeds are quite ripe. They are dried and reduced to a fine powder. This powder is used just as the snuff of commerce. It produces quite a stinging sensation, makes the eyes water, and taken in sufficient quantity induces violent fits of sneezing. When these unpleasant effects have subsided, the throat and nostrils of affected persons become free and have a "comfortable feeling." The leaves are also broken small and smoked, as cubebs, and the smoke is expelled through the nostrils for the same purpose. The juice of fresh leaves is hot to the taste, and is sometimes rubbed into the nostrils instead of "snuffing."—F. W. ANDERSON, *Great Falls, Montana.*

EDITORIAL.

THE GAZETTE has again and again spoken of the importance of an investigator consulting the literature of the subject that he is at work upon. There is still such a crying need of this sort of application that at the risk of being tiresome we propose to speak of it again.

The establishment of the agricultural experiment stations has put upon many the necessity of performing some kind of experimental work who have either had little previous training in such work, or are mentally not adapted to it. Professor Sanborn says truly:[1] "I may say, speaking of the experiment stations, that many of us will always be more or less imitators. There are but very few original thinkers and workers. * * * * The majority of men take some problem partly solved and work along that line. There are very few men in this country that lay out original lines, but these few have plenty of imitators." Now it behooves those who are following some line suggested by another's work, and especially those who are taking the partly solved problems and working at them, to know *accurately* what has been done before. For the failure to find this out two excuses are given; first, that the literature is not accessible; second, that the busy experimenter has not time. The first is somewhat of a justification; the second is utterly puerile. The difficulty caused by the inaccessibility of literature is to be overcome in two ways. In equipping the stations the library should be considered as indispensable as the laboratory. "Jahresberichts" and similar summaries *must be*

[1] At the second annual convention of Agricultural Colleges and Experiment Stations; Proceedings, p. 59.

provided if possible. If, for any reason, this is not done, the investigator must find out where such systematic abstracts can be consulted, and, either by personal visitation or by hiring some one to examine them, discover what has been done.

It is a fair presumption, and one that ought always be made in the absence of knowledge to the contrary, that every subject has been worked at before by somebody, and no one is justified in publishing a piece of work until he has assured himself that what he is about to publish contains something worth setting forth.

Such a position as this does not preclude the publication of bulletins of information by the experiment stations, for a vast deal that is well known to specialists is not known at all to those whom it would directly benefit. It *does* preclude the publication of detailed experiments on ground already well trodden, unless these approach the matter in some new way or point to some different conclusions.

CURRENT LITERATURE.

Minor Notices.

PROFESSOR E. S. GOFF has prepared a paper on the Noxious Weeds of Wisconsin, which forms Bulletin 20 of the Agricultural Experiment Station.[1] It contains a copy of the weed law of the state, which requires the destruction of the following plants under penalties: Cnicus arvensis, Arctium Lappa, Chrysanthemum Leucanthemum, Linaria vulgaris, Xanthium strumarium, Sonchus arvensis and Rumex crispus. Descriptions and illustrations of all except Sonchus arvensis are accompanied by illustrations of several other bad weeds which are not included in the law.

NOTHING DOES MORE to stimulate study of any group of plants than providing beginners with suitable keys for the determination of the plants that they collect. Professor Underwood and Mr. Cook are about to issue a century of illustrative fungi, and they have prepared a series of keys to the genera of the Basidiomycetes and Myxomycetes to accompany the set.[2] These certainly must prove extremely helpful to those for whom they are intended. Of the specimens, fifty nine are Basidiomycetes, twenty-six Ascomycetes, eight Phycomycetes and seven Myxomycetes.

PROFESSOR BAILEY has been conducting a series of careful experiments on the germination of seeds, the results of which are embodied in

[1] Pp. 27, figs. 14. Published by the State.

[2] UNDERWOOD, L. M. and COOK, O. F.—Generic synopses of the Basidiomycetes and Myxomycetes. pp. 21. The authors, Syracuse, 1889.

Bulletin 7 of the Cornell Experiment Station.[3] His conclusions as to the relative influence of constant and variable temperature on sprouting seem to us invalid on account of his apparent failure to take account of the limits of temperature for the germination of the various species of seeds used. His conclusions are essentially those of Köppen (1870), and are open to the same objections. They are contradicted by those of Pedersen[4] who found that when the temperature variations were confined to certain limits the growth seemed to be greater rather than less. His further experiments, however, showed that the temperature variations *as such* exercised no influence.

The most remarkable results are those regarding the influence of the amount of moisture on sprouting. A much larger percentage of seed germinated when the soil was kept drier than usual in greenhouses. In some cases the difference amounted to nearly fifty per cent. The best results were obtained when the soil was kept merely moist.

The other results regarding the influence of soaking before planting, soil, color, latitude, etc., are unimportant. The conclusions as to influence of weight and light accord with those of other earlier observers. Perhaps the most important feature of the bulletin is the insistence of the author upon the inadequacy both of limited testing and field planting to determine the quality of seeds, points that his researches abundantly confirm.

OPEN LETTERS.

Some Nebraska grasses.

Nebraska furnishes a new locality for two grasses which are attributed to the far southwest. *Melica Porteri* Scrib., credited from Colorado to Arizona, was collected in 1887 at Weeping Water, about thirty-five miles east of here, and within fifteen miles of the Missouri river. The second and more interesting find is *Eragrotis pilifera* Scheele, at Valentine, just west of the 100th meridian and at the extreme northern border of the state. Vasey's catalogue says it belongs down in Texas and Arizona. What is it doing way up here? E. pilifera seems more like either Molinia or Catabrosa than Eragrostis. The spikelets are 2-4 flowered. In a three-flowered spikelet, the lower flower is hermaphrodite, the second male, and the third sterile, with sometimes a pedicel projecting beyond it. If E. pilifera is to be considered as a true Eragrostis, Molinia should also be made a section of that genus.—JARED G. SMITH, *Lincoln, Neb.*

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[3] BAILEY, L. H.—On the influence of certain conditions upon the sprouting of seeds. pp. 31-71, figs. 7. Ithaca, the University, July, 1889.

[4] Arbeiten bot. Inst. Würzburg, i. 563.

NOTES AND NEWS.

THE REV. M. J. BERKELEY, the distinguished English cryptogamic botanist, is dead.

PROF. F. H. KNOWLTON is collecting fossil plants in western New Mexico, Arizona and California.

A BIOGRAPHICAL sketch of the late Heinrich Gustav Reichenbach (1823–1889) is published in *Journal of Botany* (July).

AN ACCOUNT of the botanical work done at the Toronto meeting of the A. A. A. S. will be given in the October GAZETTE.

W. W. CALKINS has gone on a trip to the mountains of East Tennessee, and will not let any lichens slip through his hands while away.

PROFESSOR E. L. GREENE spent the summer months in an exploration of the forests of Colorado, Montana, Oregon, Washington and California.

ERWIN F. SMITH is investigating peach yellows in Michigan, and before his return to Washington will visit the principal peach-growing regions of the east.

MR. M. B. WAITE is investigating pear blight, especially in its relation to the Le Conte industry in the south, under the direction of the section of vegetable pathology.

IN HIS NOTES on the synonymy of Cladrastis tinctoria, in a recent number of *Garden and Forest*, Dr. C. S. Sargent announces his adherence to the principle of the maintenance of the earliest *specific* name.

DAVID G. FAIRCHILD, a graduate of the Kansas Agricultural College, and a special student of Dr. Halsted, has been appointed an assistant in the section of vegetable pathology in the United States Department of Agriculture.

AMONG SHORT-LIVED seeds those of some of the willows are remarkable. Woloszczak finds that the seeds of Salix pentandra live only forty-eight days. Wiesner found those of S. purpurea viable for only eighty-five days.

DR. GEO. VASEY is making a tour through the west for the purpose of selecting sites for several additional grass stations. He will visit Kansas, Colorado, California and several other states, returning to Washington about the first of September.

FRANK S. EARLE, of Mississippi; Prof. E. S. Goff, of Madison, Wis.; and Prof. L. R. Taft, of the Agricultural College of Michigan, have been appointed special agents in the section of vegetable pathology of the United States Department of Agriculture.

DR. A. ENGLER has been called to the University of Berlin as professor of botany and director of the Royal Botanical Gardens. If he accepts, a worthy successor to the distinguished Eichler will have been secured. Dr. Urban has been nominated as assistant director.

M. V. FAYOD contributes a monograph of over 200 pages, entitled Historie naturelle des Agaricinés, to the *Annales des Sci. Nat.* (*Bot.*). The comparative anatomy and development of these fungi is described at length. A grouping of all the known genera, with descriptions of their characters and critical remarks forms about half of the monograph.

Dr. Dohrn, the director of the zoölogical station at Naples, appeals to all algologists to send to the station copies of papers relating to algæ, as the basis for a library for the assistance of the botanists who avail themselves of the privileges of the station. In the new building which is being erected additional accommodations will be provided for botanical work.

Drs. Lehman and Mori, in a recent paper[1] collate the literature and experiments as to the poisonous nature of the seeds of the common corn cockle, *Agrostemma Githago* L. These show that the fresh seeds are highly poisonous, but that they become entirely innocuous after roasting. The authors suggest that these seeds would form a very useful food for domestic animals.

The Bulletin of the Royal Gardens, Kew, has done a great service to botanists in giving (No. 31, July, 1889) a guide to the botanical literature of the British Empire. It was suggested by the fact that "Kew is often called upon to answer questions, on the shortest notice, concerning the vegetation of some remote part of the world, and the best books to consult on the subject; hence the idea of preparing a concise guide."

Newton B. Pierce, who has been doing special work with Prof. Spalding, at Ann Arbor, for the past two years, has been commissioned by the Secretary of Agriculture, to visit California for the purpose of investigating a "mysterious" grape disease which appeared in that state three or four years ago, and which has already destroyed many thousand vines. His work will be carried on under the direction of the section of vegetable pathology.

From an examination of the anatomical structure of the pitchers of Sarracenia Drummondii, E. Heckel comes to the conclusion that it represents a hollow petiole, and the operculum the lamina of the leaf. The resemblance in structure is very close to the petiole of Nymphæa alba, and the near affinity of the Nymphæaceæ and Sarraceniaceæ can not be doubted. The structure and arrangement of the vascular bundles are very similar. The parenchyma of the petiole of the water-lily contains large numbers of air-cavities lined with hairs. These appear to be fused in Sarracenia into one large central cavity, the cavity of the pitcher, in which we again find the hairs which prevent the escape of the captured insects.—*Jour. Roy. Mic. Soc.*, June.

Mr. L. Magnin strongly recommends[2] iodized phosphoric acid to replace the iodized chloride of zinc as a reagent for cellulose. Those who have used the latter are well aware of its shortcomings in the way of difficulty of manufacture and slowness of action. The new reagent is said to act almost instantly or within a few minutes. To prepare it take pure glacial phosphoric acid, add one-fourth to one-third of its bulk of distilled water, and then some crystals of potassic iodide and iodine until the mixture becomes of a sherry brown. In using this reagent with cellulose walls in which the presence of other matter is suspected, it is well to warm the section in a one per cent. solution of HCl or a four per cent. solution of KOH, in case the coloration does not appear promptly. The author also recommends iodized chloride of calcium and chloride of aluminium.

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[1] Archiv für Hygiene, ix. 257.

[2] Bull. Soc. Bot. France, xxxv. 421.—*fide J. R. M. S.*

THE PUZZLING and much-debated question regarding the nitrogen assimilation of plants has been receiving much attention during the last few years. In all the discussion the behavior of the Leguminosæ cuts an important figure. Recall the references in this journal recently to papers on the root-tubercles of these plants. The publication in November, 1888, of a paper by Hellriegel and Willfarth seems to have given fresh impetus to the study and discussion of this interesting problem. The conclusions reached by these experimenters (continuing Hellriegel's earlier researches) were essentially these:

The Leguminosæ differ markedly from other plants (particularly grasses with which they were compared) in their N assimilation, since the latter depend entirely on the N in the soil for their supply, while the former have an additional source in the free N of the air. This they are enabled to utilize, not by any power of their own, but through the low organisms (as to whose nature nothing is decided) which enter into symbiotic relations with the roots, and thus give rise to the tubercles. These tubercles are absent from the roots of Leguminosæ grown in sterilized soil, and are formed when to such soil a small quantity of an infusion of unsterilized soil is added. Plants from which such tubercles are absent can not assimilate free nitrogen.

These conclusions as to the great difference between the N assimilation of Leguminosæ and other plants are strongly controverted by Frank[3], who points out that Joulie, in 1885, determined the fixation of free N by ray grass and buckwheat, while he himself has demonstrated the same for some of the simple algæ. He adds details of recent experiments with oats showing a like N accumulation. In the experiment with oats the N in the soil was at the beginning 0.118 per cent. After raising nineteen strong plants, bearing 530 ripe seeds, analysis showed 0.131 per cent. in soil. This increase was probably due to refuse from the plants, such as the root-hairs and finer rootlets. The N in the seed sown was 0.0142 gm.; in the crop, 0.487 gm. In a vessel containing the same quantity and quality of soil treated in the same way, but having no plants in it, the percentage of N at the conclusion of the experiment was 0.110. Hellriegel's negative results Frank ascribes to the lack of vigor in his culture plants, and asserts that plants will not assimilate N from either soil or air unless they are strong and healthy. He also claims at length the absence of exact proof that the root-tubercles of Leguminosæ are organs of assimilation. Hellriegel's case on this point rests on the observation that among peas grown on a soil free from N some starved, while others subsequently recovered and grew well. In subsequent experiments this recovery was hastened by watering the plants with a minute quantity of an infusion of field soil. From this Hellriegel infers that the peas were unable to assimilate the free N until the tubercles were formed by the infection of the roots from the infusion, after which the plants grew well. Frank, however, interprets the experiment to mean that the peas were unable to assimilate free N because they could not, under the conditions, attain sufficient vigor. He further argues *a priori* against the probability of Hellriegel's theory, and shows the dissimilarity between the root tubercles and mycorhiza, with which they have been compared.

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[3] Ueber den gegenwärtigen Stand unserer Kenntnisse der Assimilation elementaren Stickstoffs durch die Pflanze.—Ber. d. D. bot. Gesells., vii. 234.

Protoplasm and its history.[1]

GEORGE L. GOODALE.

In the department of biology there are three subjects of transcendent interest, namely, protoplasm, or living-matter, development, and adaptation. In fact the interest in some phases of these subjects is now so general and deep that the special students in this department feel that they have to a great extent the sympathy and cooperation of the public at large. This interest renders possible the construction of such commodious laboratories as this, the latest acquisition of the University of Toronto, in which we are now permitted to meet. The generous halls and adequate equipment of this laboratory and other biological laboratories throughout our country and Europe, testify to the existence of a wide-spread belief that the new natural history has very much to learn and much to teach in regard to many of the great problems of life.

In the annual gatherings of the members of our section for the exchange of views and for better fellowship, it has been found expedient for us to look at one or the other of these three subjects at the outset of our work, in a somewhat broad and yet special manner.

Your chairman for the present year asks the privilege of selecting, as his topic for the introductory address, the first of the subjects mentioned. You are invited to examine the more recent additions to our knowledge of protoplasm, restricting the examination to discoveries in the field of botany.

Whether we consider protoplasm, or the living-matter of plants and animals, from the point of view of physics, of chemistry, of physiology, or of philosophy, we have before us a topic which has received, and which continues to receive, the most assiduous attention. Hence its literature, though comparatively recent, is appallingly voluminous, and any attempt to treat the subject, or any considerable part of it, exhaustively, within the limits properly imposed upon introduc-

[1]Address delivered by Professor George L. Goodale, of Harvard University, as Vice-President of the Biological Section of the A. A. A. S., at Toronto, August 28, 1889.

tory addresses, would result in annoyance to you and utter discomfiture for me. Apropos of this, I am reminded of a series of experiments upon protoplasm, conducted in a German laboratory, which will illustrate the embarassment which the case presents. The study to which I refer was with regard to certain organisms of very low grade. At a given period in the life of these organisms, their microscopic masses of protoplasm become confluent in such abundance that sufficient material can be procured for experiments on a large scale. In the special investigation referred to, a considerable quantity of protoplasm obtained in this way was subjected to enormous pressure. You can anticipate the result, there remained behind only a shrunken residue of what we may call, without figure of speech, the most juiceless and the driest of husks.

This natural result of extreme compression has stared me in the face during the preparation of the present address. A similar result is more than likely to follow my attempt to bring within very narrow limits the subject which I have chosen for your consideration.

The word protoplasm was coined by Hugo von Mohl in order to designate certain active contents of the vegetable cell.

We shall gain in clearness of vision by letting our glance rest first on the results of investigating vegetable cells and cell contents, anterior to von Mohl's time, in order that we may see some of the steps by which this term was reached by him. The compound microscope was not applied seriously to the examination of the structure of plants until about fifty years after its discovery by Drebbel. In 1667, Robert Hooke, of England, published an account of his investigations of minerals, plants and animals under the microscope, and gave excellent illustrations of what he thought he saw. His first reference to the structure of plants is in his description of charcoal, and this is followed by a good account of common cork. In these brief and fairly accurate descriptions, the author makes use of the word "*cell*," applying the term to the cavities in charcoal and in cork.

Hooke's interesting treatise was soon followed by two remarkable memoirs—one by an Italian, the other by an Englishman. Malpighi, of Bologna, sent to the Royal Society of London, in 1670, a work entitled *Anatome Plantarum*. The published volumes bear the dates 1675 and 1679. At the period these volumes were in the hands of the Royal Society, Nehemiah Grew, secretary of the Society, was engaged

in work almost identical with that of Malpighi, but there is no good reason to believe, as was formerly intimated, that he was indebted to Malpighi for any of the statements which he published as his own. It is, however, best for us to consider these two works together. By Grew the term "cell" appears to have been applied to the cavities in what we may term the softer tissues of the plant. It is certain that neither Malpighi nor Grew recognized, as we can now, the multifarious forms of vessels, fibres, long cells and the like, as referable to a common source. There is always a strong temptation to read in an old text some meaning which squares with our own notions, and one is greatly tempted to think that these assiduous investigators, Grew and Malpighi, detected the relationships which we know exist between the different elements of vegetable structure. But after giving them the benefit of every doubt, one fails to find in their writings any recognition of such affinities. On the contrary, these investigators were engaged in a study which naturally led them away from such conceptions. They were busy with descriptive work, outlining the arrangement of tissues in all organs of the plant which their knives could reach. They did not even break up the tissues into elementary parts, but they described and delineated with great skill the tissues as they were displayed in sections. Is it not incredible that these first works on vegetable structure, prepared only a few years after the earliest application of the compound microscope to the study of plants, should have remained for almost one hundred and fifty years the only comprehensive treatises on the subject? But the most charitable inquirer fails to find, during that long period, any other works of importance on vegetable anatomy.

Near the close of the last century, at a period characterized by activity in many departments of speculative inquiries, the subject of vegetable structure again excited considerable attention, but little substantial advance was made. In 1804 the Royal Society of Sciences at Göttingen proposed for competition certain questions relative to the structure and the mode of growth of tissues. The chief contestants for this prize were Link, Rudolphi and Treviranus. The memoirs of the first two received the prize, that of the latter honorable mention. The names of others should be referred to as having worked at or about this time in the same field, namely: Bernhardi, Mirbel, and Moldenhawer, the latter making a great advance in certain directions. But to all of these whom I have mentioned, including the winners of the prize, the important questions seem to be, how are the structural elements

distributed, rather than how they are related to each other in manner of growth and as respects their origin. With the cell contents they had comparatively little to do. They were busy with the constituents of the framework.

There appears to have been a strong suspicion on the part of some botanists during that period that all this study of the skeleton of the plant failed to go to the bottom of the question. The only wonder is that with their scanty and untrustworthy chemical appliances and with their very imperfect lenses they accomplished so much. May I remind you that the element iodine, which is the most important reagent in the examination of the contents of vegetable cells, was not employed until the year 1812; and, further, that no good achromatic and aplanatic lenses, of even moderately high power, were constructed until 1827.

Noting the more important discoveries of the next period in their order, we come first upon that of the nucleus of vegetable cells by Robert Brown in 1833, and one mode of cell division by Mohl in 1835. In 1838, the eccentric Schleiden published his Contributions to Phytogenesis, in which he states substantially that cells of plants can be formed only in a fluid containing, as chief ingredients, sugar and mucus (*schleim*). By this latter term he designated the nitrogenous matters taken collectively. At his touch all disguises fell, and for the first time the vegetable cell was distinctly recognized as a unit of structure always serving as the common basis for the formation of the innumerable shapes of the structural elements.

Next comes the master, Mohl. Armed with the best optical appliance procurable, familiar with the use of the chemical reagents then at command, and accustomed to accurate research, he reviews his own earlier work and that of his contemporaries, making rapid advance in the knowledge of the contents of the cell. In 1844, in a paper on the circulation within vegetable cells, he speaks of the living mass in each active cell, and distinctly recognizes it as that which is the treasury of stored energy and the vehicle of energy under release. He describes it as that which builds shapely forms out of unformed matter and at first hands. This substance he names *protoplasma*.[2]

[2] "Da wie schon bemerkt diese zähe Flüssigkeit überall, wo Zellen entstehen sollen, den ersten, die künftigen Zellen andeutenden festen Bildungen vorausgeht, da wir ferner annehmen müssen dass dieselbe das Material für die Bildung des Nucleus und des Primordialschlauches liefert, indem diese nicht nur in der nächsten räumlichen Verbindung mit derselben stehen, sondern auch auf Jod auf analoge, Weise reagiren, das also ihre Organisation der Process ist, welcher die Entstehung der neuen Zelle einleitet, so mag es wohl gerechtfertigt sein, wenn ich zur Bezeichnung dieser Substanz eine auf diese physiologische Function sich beziehende Benennung in dem Worte *Protoplasma* vorschlage."

If we look at the hand-books of botany just before this date of the early forties, we find references to "coagulable matters" (Treviranus), and the chemical instability of the substance within cells was suspected of having much to do with its activity, but almost all of the notes, as well as those upon the same subject found here and there in philosophical writings of the latter part of the last century, are based on pure speculation. The scientific recognition of a physical basis of vital activity must be credited to Schleiden and Mohl.

The term protoplasm was at once adopted by Schleiden, and a good substitute for the indefinite and misleading word *schleim*, which he had employed to designate essentially the same substance, and it became thoroughly established in scientific terminology. In 1850, Prof. Cohn (and Unger in 1855) showed that the protoplasm of vegetable cells is identical with what had been described, in 1835, in animal structures as *sarcode* by Dujardin, and this prepared the way for the exhaustive treatise by Max Schultze in 1858. From that date on, work in the contiguous fields of botany and zoölogy has made no physical or chemical distinction between the living-matter in animals and plants. Investigators in the two fields have been mutually helpful.

Mohl, in his treatise on the vegetable cell, published in 1851, gives the following account of protoplasm:

"If a tissue composed of young cells be left some time in alcohol, or treated with nitric or muriatic acid, a very thin, finely granular membrane becomes detached from the inside of the walls of the cells, in the form of a closed vesicle, which becomes more or less contracted, and consequently removes all the contents of the cell which are enclosed in this vesicle from the wall of the cell. Reasons hereafter to be discussed have led me to call this inner cell the *primordial utricle* (*primordialschlauch*). * * * In the center of the young cell, with rare exceptions, lies the so-called *nucleus cellulæ* of Robert Brown ('*Zellen-kern*'; '*Cytoblast*' of Schleiden). * * * The remainder of the cell is more or less densely filled with an opaque, viscid fluid of a white color, having granules intermingled in it, which fluid I call *protoplasm*."

We must now pass without notice numerous contributions to the subject and consider Hofmeister's description of protoplasm given in his Vegetable Cell, published in 1867.

"The substance protoplasm, whose peculiar behavior initiates all new development, is everywhere an essentially

homogeneous body. It is a viscid fluid containing much water, having parts easily motile, capable of swelling, and possessing in a remarkable degree the properties of a colloid It is a mixture of different organic matters, among which albuminoids and members of the dextrine group are always present. It has the consistence of a more or less thick mucus, and is not miscible with water to any great extent."

From these accounts we see that the following points were regarded as established: (1) All of the activities of the vegetable cell are manifested in its protoplasmic contents. (2) Protoplasm consists chemically of a nitrogenous basis. (3) Protoplasm has no demonstrable structure. (4) The protoplasmic contents in one vegetable cell are not connected with the protoplasmic contents in adjoining cells. (5) The nucleus and other vitalized granules in the vegetable cell are formed by differentiation from amorphous protoplasm.

It is now our duty to see in what manner these views have been modified during the last twenty, or rather ten, years. In describing the changes of opinion, time will not suffice for us to allude to most of the observers; a few only can be mentioned by name.

The first thesis, namely, that all of the activities of the vegetable cell are manifested in its protoplasmic contents, may be regarded as firmly established. It is at this point in our present examination when, if we had time, we should take up, one by one, the terms which have been applied to some parts of what Mohl and Hofmeister knew as protoplasm. But we can only glance at them in passing: Thus, *cytoplasma* is understood to be the mass exclusive of the granular contents of all kinds; *hyaloplasma* is the outer hyaline layer; *polioplasma* is the grayish granular part. To these terms may be added others, such as *paraplasma*, etc.

The second thesis, viz., protoplasm consists chemically of a nitrogenous basis, remains unchanged. But, instead of regarding the protoplasmic basis as comparatively simple, it is now known to be exceedingly complex, and to contain numerous cognate proteids, some of which can be identified in the basic mass, others in the nucleus, and others still in the vitalized granules.

These researches must be considered also with reference to those by two active investigators, Pfeffer and de Vries. The former has shown the conditions under which active protoplasm reacts in the presence of certain chemical ex-

citants, the latter has demonstrated the relations of a part of this irritability of protoplasm to its physical constitution. But, as a result of all these recent studies, it becomes more and more clear that the chemical relations of the protoplasmic activities are still veiled in mystery. Botanists are receding from a position held by many only a few years ago, namely, that it is safe to use the words albuminoids and protoplasm interchangeably; nowadays the latter term is generally restricted to morphological and physiological conceptions, the former keeps its wide chemical significance.

Just here come in the chemical studies of protoplasm; by Rodewald and Reinke on a large scale, by Loew and Bokorny, and by Schwarz under the microscope. All of these results compel us to recognize in protoplasm a substance of bewildering complexity of composition and constitution. Moreover, you all know how wide this field of research has suddenly become by the discovery that different microbes (which are, essentially, minutest masses of protoplasm) not only give rise to such diverse products, among others the ptomaines, but present such diverse chemical reacitons.

Protoplasm is no longer regarded by any one in any sense as a comparatively simple substance.

The third thesis, namely, protoplasm has no demonstrable structure, has been modified in a striking manner as a result of improved appliances for research. By better methods of staining, and by the use of homogeneous immersion objectives, the apparently structureless mass is seen to be made up of parts which are easily distinguishable. There has been, and in fact is now, a suspicion that some of these appearances, under the influence of staining agents, are post-mortem changes and do not belong to protoplasm in a living state. But it seems to be beyond reasonable doubt that protoplasm is marvellously complex in its morphological and physical as well as its chemical constitution. One statement of the case is as follows:

Under ordinary circumstances, protoplasm is composed of a mesh of inconceivable fineness, in which mesh are entangled the more liquid interfilar portions (paraplasma); so that the dry husks left in Reinke's experiment may be regarded as the residue of network from which all the moisture has been expelled. But this conception of protoplasm as a mass composed of a network of minutest fibers enclosing in the meshes another substance, presents, as has been well shown by some critics, great difficulties when we endeavor

to explain the movements within the cell. It is very difficult to explain in any way the so-called wandering of protoplasm outside the cell wall or into intercellular spaces.

Fourth, we are to glance at the accepted statement that the protoplasmic body or protoplast, as it is called, of one cell is cut off by the cell wall from all connection with the contiguous cells. There are a few cases in which this intervening wall was formerly held to be pervious, but such cases were considered as exceptional. Now, however, as has been shown by Gardiner and others who have followed out his exact researches, there are intercommunicating threads of protoplasm of extreme fineness between adjoining cells, and these living threads maintain connections, sometimes direct, sometimes indirect, between one protoplasmic mass and another. This has been shown to be so widely true in the case of the plants hitherto investigated, that the generalization has been ventured on, that *all the protoplasm throughout the plant is continuous.* The formation of the dividing wall in cell division is now better understood than ever before, and our knowledge of this process lends great probability to the truth of the general statement made. It is not unlikely, then, that all the living-matter throughout each plant is continuous, a whole, shut off at the time of severing from the mother plant from the body of protoplasm there, and thus making a true chain of descent.

May I ask you to observe, in passing, how this bears on the vexed subject of individuality of plants. Brücke, in 1862, declared that the living protoplasmic contents of a cell formed an elementary organism, and this idea found its fullest expression in the profound work by Hanstein in 1880. In that treatise Hanstein proposed for the living protoplasmic contents of the cell the term protoplast, in order to indicate its individuality. But these late researches show that these protoplasts are not only highly organized and of complicated structure, but each is bound by indissoluble ties to its nearest neighbors, each helping to form a united whole.

The fifth thesis has been completely controverted. Instead of believing, as formerly, that all the granules within the cell arise *de novo* from the protoplasm in which they are imbedded, we are now forced to regard all of them as springing from pre-existent bodies of the same character.

Hofmeister, in 1867, in an exhaustive description of the contents of vegetable cells, states distinctly that the nucleus arises from homogeneous protoplasm, and that in all cell

division the nucleus must first disappear, two new ones arising in its place. The nucleus occupied a secondary place as a derivative organ. And the chlorophyll granules were believed by him and his contemporaries to be new formations from homogeneous protoplasm under certain conditions of light, temperature and food. Researches, which leave no room for doubt, have shown that the nucleus, in all cases hitherto examined, springs from a pre-existent nucleus by a process of division. The process of division, with its marvelous sequence of formal arrangements of definite portions in meridional lines and in polar and equatorial masses, has been most carefully examined in almost every organ of the plant, and in connection with similar processes of cell-division in animal tissues. In no well marked case has a nucleus been observed to arise from homogeneous protoplasm, even a few doubtful instances having been lately explained satisfactorily.

The extraordinary manner in which the nucleus, both in common cell-division and in reproductive blending, carries ancestral characters and controls the distribution of nutritive materials, is as yet the greatest mystery in vegetable life.

We pass next to consider a very important change of view in regard to the other granules imbedded in the protoplasmic body, known as leaf-green or chlorophyll granules. Formerly, as we have noticed, it was held that all of these sprang by a process of differentiation from the shapeless mass in each exposed cell. Researches by Schmitz on some of the lower plants, and by Schimper and Meyer on the higher, have shown beyond any reasonable doubt that these chlorophyll granules always arise by a process of division from preexistent granules. But this fact, taken by itself, might not possess great interest. It is, however, known that at the growing points where leaves are developed, the cells contain in their protoplasm granules of about the consistence and color of protoplasm itself, and these granules have the power of division, much after the fashion of the cell nucleus. But the products of such division are essentially three-fold ; some of the resulting granules are colorless, like the mother granules, others become true chlorophyll granules, while others still, in those leaves which become the leaves of the flower and the fruit, assume colors other than green. In other words, we have in these associated granules, or chromatophores, a morphology which is of the highest interest. The

needs of the plant bring from this common source the microscopic organs for assimilation, for storing up starch in the form of grains, for protection and attraction. This most interesting generalization in regard to the granules taken together, adds a new zest to the study of the developing plant and the evolving species.

It has been lately claimed by de Vries of Holland, that the sap-cavities or vacuoles in protoplasm divide in much the same way as do the granules just referred to, but this part of the subject is not yet beyond all doubt. That the sap cavities are the birthplace of most crystals, and that the aleurone grains may be desiccated sap cavities has been made out by several observers. But it is not clear that vacuoles divide as granules do. What we do know beyond all reasonable question is this—that all the working granules within the plant have sprung from pre-existent granules, and that there is no break here in the transmission from parent to offspring.

Such, then, are some of the more important changes which have taken place with regard to our knowledge of the living contents of vegetable cells. I would gladly take the time, if it could be granted, to call your attention to certain most interesting discoveries which have been made by Pfeffer relative to the absorption of coloring agents by living protoplasm, and which have been supplemented by Campbell in regard to the nucleus. But more than this allusion is now impossible.

It is an interesting coincidence that with the substitution of the crude compound microscope for high power simple lenses in 1660, came the first works on vegetable structure, and for more than one hundred years, or until the introduction of achromatic object glasses, these works were in truth the only authoritative treatises. With the introduction of water-immersion lenses came renewed activity in this field, and with the later discovery of homogeneous immersion lenses came the results which have now been detailed. Whether we have, at these stages, more than a series of interesting and very striking coincidences, or not, we have not time now to discuss. It is enough for our present purpose to observe that, with the introduction of the cedar oil immersion objectives, a thorough reinvestigation of certain parts of this subject began. One may be pardoned for asking whether the objectives known as apochromatics are to open up in this field new lines of research.

Can these recent discoveries relative to the continuity of

protoplasm and the genetic relationship of the associated granules (including, in the widest sense, the nucleus), be made to cast any light on the question of development, as they certainly do upon the kindred question of adaptation? The answer has been given us very lately by Hugo de Vries of Amsterdam. This investigator, who has done very much to clear up certain obscurities in regard to the external relations of the cell, has recently revised the neglected doctrine of pangenesis and applied it to the question just propounded. De Vries suggests that we divide the hypothesis of pangenesis as proposed by Darwin into two parts, as follows: (1) In every germ-cell individual characters of the whole organism are represented by material particles which, by their multiplication, transmit to descendants all of such peculiarities. (2) All the cells of the organism throw off, at certain periods of development, such material particles, which flow towards the germ-cells, supplying its deficiencies. Now de Vries asks whether it is not high time for us to look at the first part of this hypothesis again, and abandon the hindrances which the latter part imposes. If we accept his suggestion, and restate the hypothesis, in view of what has been learned relative to the nucleus and other granules (the trophoplasts) within the cell, we should then read:

In every cell at a growing part are all the elements ready for multiplication. Each protoplast possesses the organs necessary for continuous transmission; the nucleus for new nuclei, the trophoplasts for new granules of all kinds according to the needs of the plant.

The author reviews the theories bearing on the question from the so-called plastidules of Elsberg to the germ-plasma of Weismann, and then applies his hypotheses of intra-cellular pangenesis to the different parts of a single plant and to the transmission of peculiarities. The active particles recognized in Darwin's hypothesis he terms *pangens*, and, regarding them as vehicles of hereditary characters, traces them throughout their course. He is not obliged to ask for any means of transportation for these pangens, for they work, so to speak, on the spot. They are ready at hand at the points of growth. We must look very sharply with reference to this at two points of growth in the flowering plant, namely: the bud and the seed. Each bud, with its growing point made up of cells containing in their protoplasm the divisible granules, carries with itself all the peculiarities which have been transmitted without appreciable change. In the formation of the

bud there is fission, but no blending. The cells divide, and each new one may in turn divide until the ultimate form of the leafy branch or flower is reached. In the leafy branch new buds form, and in their turn carry forward the ancestral peculiarities. But in the flower, on the other hand, with the formation of the ovule, all development is arrested (except in the rare cases of parthenogenesis and the like) unless the protoplasm of the embryonal sac receives a new impetus from material contributed by the pollen grain. And in this blending of parts which have developed under different external conditions, we see that there is a chance for variation to come in. Not only is there a blending of the nuclei, but a sharing of the accompanying trophoplasts. How this can be applied to the lower plants and other organisms can not now be referred to. It would not be right to hold de Vries wholly responsible for the application just given, but I ask you whether the hypothesis does not appear fruitful. It seems likely to stimulate speculation and further research in this important field.

In view of de Vries' work, and of the results of recent study, which I have endeavored to bring before you this afternoon, does not the statement of Darwin possess new force?

"An organic being is a microcosm, a little universe formed of a host of self-propagating organisms inconceivably minute and as numerous as the stars in heaven."

Cambridge, Mass.

Paraguay and its flora. II.

THOMAS MORONG.

It would be out of place in an article like this for me to attempt to enumerate even a tithe of the trees found in these dense Paraguayan forests, but among those best known abroad are the India-rubber (Siphonia elastica), Erythroxylon Coca, logwood (Hæmatoxylon Campechianum), Salix Humboldtii, Carica Papaya, Quillaia saponaria, Fabiana imbricata, Nectandra, Franciscea uniflora, the Omber (Pircunia dioica), and Juga dulcis. Something of their character and numbers may be seen in the collection of her woods which Paraguay has sent to the present Exposition at Paris. The collection is in part composed of one made several years since for a similar exhibition at Montevideo, to which large additions have been made by Dr. Emile Hassler, who has

charge of the matter. The specimens, which have been carefully prepared in sections so as to show the bark and the interior fiber of the wood, together with many thin squares polished and framed, number in all 233 different species. To these Dr. Hassler has added specimens of charcoal made of different kinds of wood, 93 specimens of trees, shrubs and herbs which are used for medicinal purposes, 38 that yield textile fabrics, 8 of them furnishing vegetable silk, and 25 from which excellent materials for coloring and dyeing are obtained. Few countries of the size of Paraguay, which scarcely equals the state of Colorado[1] in area, could make such an exhibition. Brazil is probably the only South American country which could surpass this little territory in this respect.

In table supplies Paraguay is hardly surpassed by any nation on the globe. To say nothing of the ordinary garden vegetables, nearly all of which are easily cultivated in her fertile soil, she has of fruits the orange, the lemon and the citron, all growing here to perfection and without culture; the fig, banana, pine-apple, peach, grape, guava, papaw, water-melon and musk-melon, both of fine quality and raised with scarcely any care; the cocoa-nut (that is, the small cocoa-nut mentioned above, which is very edible), pea-nut, sterculia-nut (similar to cocoa), and many other wild fruits for which there are no popular English names. Of other valuable productions she furnishes the far-famed Yerba-maté (Ilex Paraguayensis), a tea drank by eighteen million people in South America, the best and by far the greater part of which grows wild in her eastern Cordilleras; coffee, as good as that of Brazil; cotton, equal to any upland cotton of the United States; tobacco, which is raised in large quantities; mandioca or cassava, regarded with good reason as an excellent substitute for wheat flour; maize or yellow corn, grown abundantly by the farmers; sugar-cane, of the best quality; sorghum, Irish and sweet potatoes and yams, rice, the egg-plant, and many fine pasturage grasses. We must take into the account, too, that this country is agriculturally yet in its infancy. The farming is very limited, and at best of the poorest sort. The conditions are all favorable for raising nearly everything which can be grown in a semi-tropical climate, and I have no doubt that in time scores of other fruits and vegetables will be success-

[1]Paraguay has an area of about 100,000 square miles, while Colorado has over 104,000 square miles of territory.

fully introduced from abroad into this well-watered, sunny and fertile land.

The most prolific order of plants found here is, of course, the Compositæ, as it is in all other countries. Many members of the order, however, are shrubs, some even attaining the stature of trees. Others possess a floral structure which is very strange to a botanist from the United States. One of them has four small, inconspicuous, deciduous staminate flowers right in the center of the receptacle, which are surrounded by a row of large achenia surmounted by hooked spines and small corollas, and becoming in fruit sharp-thorned burrs that are a great nuisance. Another large and succulent plant bears along the upper side of its curving stems rows of the most beautiful variegated green and white rosettes, looking as if made in a milliner's shop for a lady's bonnet. Still another species has conglomerate heads, the outer involucre consisting of three large foliaceous scales, and within many separate bundles of heads, each bundle furnished with a set of scales, and each head with its own proper scales. I have found several species which bear these peculiar compound heads. The strangest of all is a composite which has only one sheathing involucral scale. Perhaps, however, as the scale bears five small lobes at the summit, it may be said that five scales have so completely coalesced as to appear only one. This flower runs all to 5's. The involucre has five lobes, and also five rows of curious yellow glands sunk beneath its surface. There are five flowers in the head, five pappus scales, five lobes to the corollas, and five stamens. Besides, it is stipulate; the stipules consisting of three-branched, and sometimes of five-branched hairs. Some of the composites have leaves with a a curious margin not described in the books, bearing at intervals lunate indentures or depressions, each with a corresponding brownish lunate gland, sunk below the surface of the leaf, a short distance beneath it.

The Leguminosæ rank next in number to the Compositæ, presenting innumerable species of Acacia, Mimosa, Cassia, Phaseolus, and other genera. Then come the Asclepiadaceæ and Bignoniaceæ, many of which, perhaps the most, are lianas that clamber our shrubs and trees, with conspicuous flowers and fruits. Of the former, two species have interested me exceedingly. They belong to that curious South American genus, the Araujia. Some of the readers of the GAZETTE may remember an article in the *American Nat-*

uralist, by E. C. Stearns, which was quoted in the *Popular Science Monthly* for March, 1888, in which the writer describes the moth-catching propensities of A. albens, a native of Buenos Ayres. I think that all the species of Araujia are moth catchers. At least one of those that I have collected here is so, of which I had an interesting illustration. This species differs a good deal from A. albens. It bears axillary clusters of fragrant white flowers, the corollas of which have long segments that are twisted spirally about each other somewhat like the arms of a boy's paper windmill. The first time I came across this plant I found a large humming-bird moth imprisoned by a flower, and struggling desperately to get free, but in vain. It had thrust its proboscis into the flower in search of honey and was utterly unable to withdraw it, although a very powerful insect, in fact, as large as one of the smaller humming-birds, which it much resembles. I intended to keep the insect in place, dissect the flower, and ascertain just how it was confined, which I confess I do not understand, notwithstanding the description of Mr. Stearns, but in plucking the flowers I accidentally liberated the moth and so lost the opportunity of investigation. Another species here is a very conspicuous climber, with large, solitary, axillary and fragrant blossoms, and an immense spine-covered fruit almost as large as a cucumber.

The Bignonias are some of them tall trees, and others climbing plants, usually with showy flowers, very long pods, and winged seeds. They generally blossom late in the year, many of them adorning the forests in the winter season. Nearly every thicket abounds with climbers of various kinds, some of which mount to the tops of the tallest trees, choking and finally killing them with their exuberant growth. Indeed, vegetation here is so prolific that it is difficult to penetrate the thickets without a hatchet or axe in hand. Trees and shrubs, vines and runners, crowd into every available foot of space, and one must wind through them like a fox or a squirrel. The shade within is so great that a person can scarcely pick his way along. Fallen trees obstruct the course at every step, and a road or path unused for six months becomes so covered with new growths and decaying logs that it is impassable. Even traveled highways and railroads have to be cleared almost monthly of the vegetation which constantly encroaches upon their borders.

Nor is this the only difficulty which a botanist experiences

in herborizing in Paraguay. If he succeeds in capturing rare botanical treasures, he can not do it without much trouble. He either runs the risk of broken limbs in the attempt to climb high trees, or of sore wounds if he incautiously catches hold of a shrub or a liana. Nearly every arborescent plant is armed with stout, sharp thorns, which tear his clothing and very likely something else more sensitive than cloth. Here is a lovely Acacia, with bright yellow blossoms, which I covet, but in an instant it has caught my coat at a dozen points with its keen hooked spines. If I attempt to tear myself away, lo! several great rents in my coat, and unfortunately no fireside companion at hand to make the rents whole again. If I cut off a branch with a jerk of the knife, half a dozen deep gashes in my hand is the result. Here is a beautiful climber, the flowers of which I must have, but in order to get it, not only must I encounter the spears of a host of encircling Yuccas and the prickles with which the climber is itself clad, but I must also break through the spiny armor of an Acacia, around which the stems have managed to twine themselves so closely that they can scarcely be touched at a single point without a wound. Again, I see a beautiful shrub, of I know not what genus, which bears a large evergreen leaf and handsome clusters of rose-colored Camellia-like flowers. I hasten to transfer specimens to my portfolio, but hidden under the bright leaves and charming flowers is a stem bristling at intervals of a few inches with verticils of branching prongs, an inch and a half in length and as sharp as needles, and what is even worse, these needles infuse a poison into the wound which they make and cause it to fester.

Other plants harbor colonies of ants, by which they seem to be benefitted, or, at least, protected, and if you dare invade their premises they resent it instantly and pour forth in angry swarms. Nor is their bite to be despised. I once plucked a stalk of grass from the ground, and before I could place it in my portfolio my hand was covered with small red ants, whose stings burned like hot coals. It was the "fire ant," insignificant enough in looks, but so venomous of sting that every one avoids it. Other colonies climb trees, and with plasters of mud convert old birds' nests into habitations, which it is really quite dangerous to molest except with lighted matches. On another occasion, while leaning down to collect plants, I happened to place my hand against the trunk of a dead tree, but a sharp stinging sensation soon warned me that my hand

was resting upon something besides dead wood. It was the home of a colony of what is called "soldier ants," an insect nearly half an inch long and with a round black head which seems to be one-third the size of its body, and armed with formidable forceps. In a spirit of spitefulness, I took a stick and broke their nest to pieces, and so fierce were the creatures that they attacked my stick viciously, and doubtless would have bitten me to death could they have reached me. Plants which are defended by such ants and also by large red wasps, hornets and spiders, which make their home upon them, are not to be touched with impunity. A wasp whose bower I had entered in search of specimens, stung me so severely that I was glad to retreat with the most unceremonious haste.

Other plants are guarded against mutilation in a different, but perhaps none the less effective, manner. They pour out a copious discharge of acid, milky juice, which sometimes raises a blister upon the skin, and is always unpleasant to encounter. An Asclepiad growing near Asuncion, from which I cut branches, discharged such large drops of viscid milk upon my hands and clothing that I wished I had let it alone, and the specimens adhered to the leaves of the portfolio and the sheets of drying paper as though they had been smeared with postage-stamp mucilage. On another occasion, while making my way through a dense wood, I heard a pattering like the falling of rain-drops. As it was a bright, sunshiny day, I was curious to learn the cause of the sound. Upon investigation, I found that it was occasioned by drops of milk, which were falling in a shower from the leaves of a large tree. The ground was quite white with the drops. Many cattle were grazing in the vicinity, but I noticed that they scrupulously avoided this tree, and never browsed upon its leaves, although they ate almost everything else within reach.

The greatest obstacle to the preservation of botanical specimens lies in the excessive humidity of the climate. The atmosphere seems to be loaded with vapor at all times, even in the most cloudless weather. The average annual rainfall at Asuncion, and probably that of Paraguay in general, is about 70 inches. Some scientists estimate it as high as 80 inches.[2] This year, according to meteorological statistics kept by government, the rainfall has been a little more than 70 inches. With such an amount of humidity in the air, of

[2] Notes of a Naturalist in South America, by John Ball, p. 299.

course many things will mould in spite of the utmost care. It must be remembered also that the houses are built of brick, one story in height, with brick floors, and entirely without appliances for obtaining artificial heat, so that they are always damp. My books, shoes, leather straps, paper and presses, and even my wearing apparel, are generally more or less moist when not exposed to the sun. Specimens dried in the sun are sure to become damp and limp during the night and in rainy and cloudy weather, which sometimes lasts for several days. Added to this is the natural tendency of many plants to drop to pieces in the process of curing. The new-comer, good easy soul, naturally supposes that, with such a hot sun, his specimens are sure to dry easily and quickly. Experience will soon convince him to the contrary. Take this shrubby Ipomœa, which is very common in the lowlands around Asuncion. The flowers are as large and showy as those of a morning-glory. Let the collector place specimens in the best order between his driers, and change them every hour if he chooses. In less than three days he will have the pleasure of seeing flowers, leaves and buds, all disarticulated. I worked over scores of specimens of this plant. I tried every expedient that I could devise, took pains to get young and fresh plants, split the stems in two, exposed them to sun heat; but all in vain. I have never succeeded in preserving over half a dozen specimens in which the leaves or flowers adhered to the stem. Take this pretty little red-flowered papaveraceous plant, and carefully arrange that in your press. In three weeks it is just as juicy as ever, and, still worse, there is nothing left of it but fragments. The floral organs have fallen to pieces, petals, sepals, styles and all, and only *disjecta membra* lie on the paper, leaving a bare stem, and perhaps even that has become dismembered with the rest. Here is a lovely Commelyna, which I wish to send home to delight North American eyes. The corolla is large, of a bright azure blue. I put that in press, and in an hour's time look at it. In that short period the petals have apparently been converted into a little pool of water! Like the manufactured thing here which they call *ice*, a piece of which dissolves while you are pouring water into the tumbler, so this charming flower has *melted!* All that is left of the petals when dried is a small, shrivelled, membranous heap which hardly wears the aspect of a flower. The stem and leaves, however, make up for the evanescence of the corolla, for they will keep green and succulent for six weeks under pressure.

Of course, a zealous and persistent botanist will surmount all these difficulties in one manner or another, but it will be seen from my account that it is no easy task to collect and preserve the members of the Paraguayan flora. Begonias, which abound here, and other succulent plants, are exceedingly difficult of management. Some plants, like the Calamus, can not be dried in any decent shape, and others, like the Victoria regia and several of the Cacti, can not be preserved at all. They will mould or rot in despite of every expedient. Many specimens must be preserved, if at all, in fragments, and pieced together upon the mounting paper.

Notwithstanding all this, I have managed to get together about 750 species and some 8,000 specimens, which I trust will be in a sufficiently good condition when they get home to be identified and to make a valuable addition to the herbaria of the United States.

Asuncion, Paraguay.

The grasses of Roane Mountain.

BY F. LAMSON SCRIBNER.[1]

Roane Mountain, lying on the border line between Tennessee and North Carolina, has been made famous as the botanizing ground of some of our best botanists, including even Dr. Gray, who first visited it in 1841, and its flora possesses a peculiar as well as a historical interest. In the old register of the hotel are recorded the finds of the several botanists or botanical parties who have visited the locality. The first of these was made in 1878 by Dr. Geo. Vasey, who, under the head of "Grasses of Roane Mountain," enumerates the four or five species observed by him.

As the guest of Mr. C. M. McClung, a prominent business man of Knoxville, Tennessee, and an enthusiastic student of North American plants, I spent a few of the last days of July of the present season upon the mountain, and improved the occasion by investigating the grasses of the locality. As the result of three days' rather diligent search, we together found on or near the mountain summit (all at an elevation of over 6,000 ft. above sea level) twenty-five species, of which the following is a list:[2]

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[1] Read before Section F, at the Toronto meeting of the A. A. A. S. 1889.

[2] I have already, in a paper read before the Society for the Promotion of Agricultural Science at the Toronto meeting, considered the grasses of this region from an agricultural aspect.

Phleum pratense L.
Agrostis perennans Tuck.
" scabra Willd.
" rupestris Chapm.[3]
" alba L.
Cinna pendula Trin.
Brachyelytrum aristatum Beauv.
Calamagrostis Canadensis Beauv.
Dactylis glomerata L.
Eatonia Pennsylvanica Gray.
Glyceria elongata Trin.
Poa annua L.
" compressa L.
Poa pratensis L.
" alsodes Gray.
Festuca elatior L.
" nutans Willd.
Bromus ciliatus L.
Elymus striatus Willd.
Asprella Hystrix Willd.
Danthonia spicata Beauv.
" compressa Austin.
Trisetum subspicatum, var. molle Gray.
Deschampsia flexuosa Griseb.
Holcus lanatus L.

Some of these species had evidently been introduced, for example Dactylis glomerata, Festuca elatior, Phleum pratense and Holcus lanatus, but all among those not natives, excepting the orchard grass and tall fescue, were well established. Deschampsia flexuosa, growing in exposed situations on rocks and ledges, was one of the most conspicuous and showy species. Poa annua was everywhere along the roads and walks and about the hotel. Poa pratensis and P. compressa were quite generally distributed, and so were the several species of Agrostis, excepting A. rupestris which was found only at High Bluff about a half mile southwest from the hotel. Glyceria elongata was seen growing rather abundantly along a stream near the mountain summit and I mention it particularly to call attention to the fact of the discovery of this northern grass within the southern states. For the same reason I would speak of the finding of Trisetum subspicatum var. molle. Poa alsodes, found several years ago on Black Mountain by Mr. Wm. M. Canby, was seen at several points, but not in any quantity. Danthonia spicata occupied its usual station in dry soil

Agrostis rupestris Chapm., figured from specimen from Roane Mt., N.C. *a*, apex fl. glume; *b*, floret; *c*, spikelet; *d*, group of three spikelets.

[3] This is the *Agrostis rupestris* of Chapman's Flora, but its identity with the plant of Allione may be questioned. The same form occurs on the mountains of New England.

along the ridges and bluffs. Danthonia compressa, distinguished by its greener color, much longer and more abundant leaves, taller culms, more elongated panicles and especially by the longer teeth to the flowering glumes, was the most abundant species of all and the chief component of the luxuriant and dense turf covering the extensive meadows of the treeless areas on the mountain top. The abundance of this grass and the excellent condition of the cattle grazing on it clearly showed its importance as a forage plant. It is a species found along the mountains from the Carolinas and Tennessee to New England, and wherever it grows abundantly yields excellent fodder for horses and cattle. A cool climate and abundant atmospheric humidity are apparently essential to its best growth.

Another species of Danthonia, viz., Danthonia Californica, especially the variety unispicata, occupies a similar position with respect to its abundance and value for forage, in the mountain meadows or "deer parks" of the Rocky Mountains in Montana.

The principal native fodder grasses of the high mountain meadows, or as they are familiarly termed in the west, "deer parks," are:

For the Alleghanies:
Danthonia compressa Austin.
For the Rocky Mountains in Montana:
Danthonia Californica var. *unispicata* Thurb.
Danthonia intermedia Vasey.
Festuca scabrella Torr.
Alopecurus occidentalis Scribn.
For the mountains of Arizona:
Poa Californica Vasey.
Muhlenbergia virescens Trin.
Muhlenbergia gracilis Trin.

Knoxville, Tenn.

Pickerel weed pollen.[1]

BYRON D. HALSTED.

The flowers of the pickerel weed (*Pontederia cordata* L.) are strictly trimorphic, as was determined by Mr. W. H. Leggett in 1875. There are six stamens in each blossom, placed in two sets of three each, and a single style. The

[1]Read before the Botanical Club of the A. A. A. S., at the Toronto meeting, 1889

shortest set of stamens is near the base of the corolla tube, and the anthers are not in the same plane, a condition due perhaps to the confined space. A similar variation is, however, found in the other sets of stamens without the same apparent reason. The anthers of all three sets are practically of the same size and color, and might be easily mistaken for each other when the filaments are removed. As in all truly trimorphic flowers, there are six possible kinds of pollen and eighteen combinations of pollen with the stigmas. There is a remarkable range in sizes of pollen, but only three prevailing dimensions, as the following table shows in micro-millimeters:

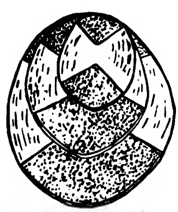
		Dry.		Wet.
Long stamens:	Short style,	22.4 × 57.6	—	44.8 × 54.4.
	Mid style,	25.9 × 51.2	—	44.8 × 57.6.
Mid stamens:	Short style,	19.2 × 42.6	—	32. × 41.6.
	Long style,	25.6 × 51.2	—	35.2 × 44.8.
Short stamens:	Mid style,	12.8 × 28.8	—	25.6 × 28.8.
	Long style,	12.8 × 28.8	—	25.6 × 28.8.

By averaging each set, we have:

	Dry.		Wet.
Long stamens,	24.1 × 54.4	—	44.8 × 56.
Mid stamens,	22.4 × 46.9	—	33.6 × 43.2.
Short stamens,	12.8 × 28.8	—	25.6 × 28.8.

The measurements of the dry and wet pollen indicate a great change in size and shape when water is added to the dusty pollen as it comes from the dehisced anthers. When dry it has two sutures in the outer coat and resembles a wheat grain in general appearance, but upon the application of water the inner wall enlarges, expands between the two slits in the outer wall, and the grain becomes elliptical or nearly spherical.

Referring to the table of averages it will be seen that the measurements for the short stamen pollen are about half of those for the grains from the longest stamens, and if the size of the smallest pollen, when wet, is represented by $3 \times 3\frac{1}{2}$ inches those of the largest will be 6×7 and the corresponding relative size of the mid stamen pollen is $4\frac{1}{2} \times 5\frac{1}{4}$, or a half of the sum of the figures for the extreme forms.


Three sizes of moist Pontederia pollen.

By glancing at the relative sizes of pollen in other trimorphic plants, as recorded by Darwin and others, it is found for—

Lythrum Salicaria,	as 10 — 7 — 6,	or 100 to	60.
Nesæa verticillata,	" 13 — 9½— 8½,	" 100 "	65.
Oxalis speciosa,	" 16 —13 —11,	" 100 "	69.
Oxalis Validiviana,	" 8½— 7 — 6,	" 100 "	71.
Oxalis Rignelli,	" 9 — 8½— 7,	" 100 "	78.

In a trimorphic Pontederia discovered by Fritz Müller in Brazil, the relative sizes of pollen as determined by Darwin[2] are 16—13—9, or 100 to 55. Our own species, therefore, by reducing to the same terms, is as 100 to 54, which accords to Pontederia cordata the greatest range for pollen that has yet been found in any flower.

The variation of pollen among dimorphic flowers does not approach this, as the following short table of the most striking illustrations shows:

Forsythia suspensa	as 100 to 94.
Pulmonaria angustifolia	" 100 " 91.
Polygonum Fagopyrum	" 100 " 82.
Pulmonaria officinalis	" 100 " 78.
Phlox subulata	" 100 " 75.
Primula vulgaris	" 100 " 71.
Primula veris	" 100 " 67.

When the contents of the pollen grains are taken into consideration it is seen that those of the largest stamens of Pontideria cordata are to those of the smallest as 8 to 1. Mr. Leggett[3] was aware of this remarkable difference at the time of his study of the flowers, but he was in doubt as to the smaller being perfect. To throw some light upon this point six small wells in an artist's slab were filled with sugar solution, and into two of them the largest pollen was placed—one lot from flowers with mid styles and the other from a short-styled form. A corresponding set was made for each of the other sizes of pollen. The largest grains germinated with the greatest promptness and vigor, and the tubes were naturally much broader and in every way larger than with the smallest sized grains, which as above stated contained only one-eighth as much of substance. There was no observed difference in pollen of the same set of stamens from flowers with different lengths of styles, and all sizes were equally able to germinate when sufficient time was given. The largest pollen tubes need to penetrate a style nearly an inch in length, while the short styles are exceedingly short. As far as I know it is invariably true with both dimorphic and trimorphic plants that the longest grains are borne by the longest stamens, and designed for the longest styles. Therefore, other things remaining constant, the length of style may be an index of the size of the pollen.

New Brunswick, N. J.

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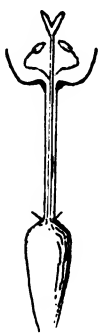
[2] Different forms of flowers on same species, p. 186.

[3] Torrey Bulletin, Nov. 1875.

Botany in the American Association.

The following papers were read before the Biological Section of the A. A. A. S. at Toronto;

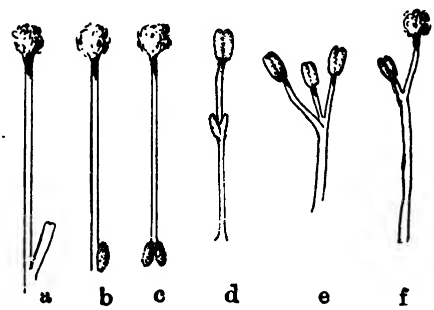
On the position of nectar glands in Echinops, by THOMAS MEEHAN.


Section of flower of Echinops.

The comparatively long corolla tube is quite filled with the style, leaving no passage for the tongues of insects. The nectar glands, however, instead of being at the base of the tubes as usual, are at the top. This arrangement permits the nectar, which is very abundant, to be taken by short tongued insects. The plant has recently come into cultivation for bees.

On the epigynous gland in Diervilla, and the genesis of Lonicera and Diervilla, by THOMAS MEEHAN.

At the base of the style in Diervilla there is a large gland (*a*), the significance of which has not been explained. In Lonicera there is a small gland (*b*) readily overlooked, or rather a pair of glands (*c*.) Careful inspection will also show the gland in

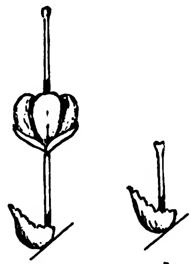


Style of Diervilla *a*, and stamens and styles of Lonicera *b* to *f*.

Diervilla to be double. In the cultivated honeysuckle, L. sempervirens, there are rudiments of glands (*d*), and in a monstrous form these are replaced by stamens (*e*). An instance was once seen of a stamen borne laterally upon the style (*f*). From this series of forms it seems clear that the glands in Lonicera and Diervilla are really rudimentary branches.

On the assumption of floral characters by axial growths in Andromeda Catesbæi, by THOMAS MEEHAN.

This species has been considered diœcious. What has been taken as a flower (*a*) with abortive stamens in the sterile plant is shown by comparison with the corresponding parts of a fertile flower (*b*), to be only the pedicel with petaloid bracts at its base.



Floral parts of Andromeda Catesbæi.

On the significance of diœcism as illustrated by Pycnanthemum, by THOMAS MEEHAN.

The author observed that plants of P. muticum, with apparently perfect flowers, produced no seeds, while plants growing near P. lanceolatum, evidently without stamens, were well provided with seeds. As no other plants of these species grew in the vicinity, it seems to be a case of hybridism. This was used to illustrate the author's belief that hybridism is not a factor in evolution, but a conservative force in herecity, and that diœcism does not favor the evolution ot forms, but acts as the handmaid of heredıty, to bring back toward the normal condition forms that have wandered.

Some physiological traits of the solid-stemmed grasses and especially of Indian corn, by F. L. STEWART.

The author had ascertained by several seasons' experiments that when corn has the ears removed at the time the kernels are hardening, that the life of the plants is greatly prolonged, and the sugar in the stock much increased. The economic bearing of this fact was indicated.

On the genus Eleocharis in America, by N. L. BRITTON.

There are about forty North American species, of which thirty-six belong to the United States. E. pygmæa and E. pauciflora are excluded from the genus. No new species are made.

On the tropical distribution of certain sedges, by N. L. BRITTON.

The abundance of species in different genera in the new and old worlds were compared, and also to some extent their boreal and austral distribution.

On the flora of New Jersey, by N. L. BRITTON.

Giving some account of the collection of data for the compilation of the final report on the flora of the state, which is soon to be issued.

The new botanical laboratory of Barnard College, by N. L. BRITTON.

This is the annex for women to Columbia College, to be opened in October. The botanical department is under the general supervision of Dr. Britton, but the students will be in the immediate charge of Miss Emily L. Gregory.

A suggestion concerning scientific work, by WILLIAM R. DUDLEY.

As economic interests largely determine the direction of scientific research in this country, it is well to bear in mind that the fresh-water algæ, up to the present time almost entirely neglected, hold an important place in sanitary matters, and are therefore entitled both from a scientific and an economic stand-point to more attention from investigators.

Notes on seedlings of Elymus Virginicus, by W. J. BEAL.

Notes on bird's-eye maple, by W. J. BEAL.

These papers were illustrated, especially the latter, with many excellent and interesting specimens. Various forms of bird's-eye markings were described, both in the maple and other kinds of woods. Tracing them back to their earliest stages did not reveal anything regarding the inciting cause or causes.

Notes upon stamens of Solanaceæ, by BYRON D. HALSTED.

Solanaceous stamens have three modes of dehiscence, and in other ways show much diversity, but one character appears to be general and limited to the order. This is the presence of a cone or "columella" in each theca. Apparent exceptions will be met with in examining mature stamens, as in Datura, which, however, find explanation in the early stages of growth. This character in connection with measurement of the pollen furnishes valuable aids in classification of the members of the order.

Reserve food substances in twigs, by BYRON D. HALSTED.

The details of the observations have been given in Bulletin No. 4 of the Iowa Agric. Exper. Station. He concludes that a deposition of starch is an indication of maturity, and only indirectly of the hardiness of the plant. Grit due to the lignification of the pith cells in pear, apple, etc., is associated with the deposition of starch.

A bacterial disease of carnations, by J. C. ARTHUR.

The disease appears to be wide spread, but its characters were not heretofore well defined. It shows most prominently in a gradual dying of the leaves and general weakening

of the plant. ·The points of attack are easily visible in the early stages of the disease, as transparent spots when viewed by strong transmitted light. A Micrococcus, pure cultures of which were shown, has been demonstrated to be the cause of the disease, by direct artificial infection.

Grasses of Roane Mountain, by F. LAMSON SCRIBNER.

Published in full in another part of this journal.

Revision of the United States species of Fuirena, by FRED. V. COVILLE.

Three species are admitted: *F. scirpoidea* Michx., *simplex* Vahl, and *squarrosa* Michx., and vars. *hispida* Chapm. and *pumila* Torr. of the last species. These can be distinguished by the perianth scales and bristles.

A bacterial disease of Indian corn, by T. J. BURRILL.

Has been known some time, but its nature not recognized until recently. The plants have a yellowish and dwarfed appearance, with exudation near the ground. The bacteria have been cultivated.

An observation ou Calamintha Nuttallii, DAVID F. DAY.

The first flower is apical and contains five nutlets instead of the usual four. This appears to be a step toward the peloric condition.

Fermentation of ensilage, by T. J. BURRILL.

The temperature usually rises during the fermentation of ensilage to a point (60° C.) that stops most if not all growth except that of a single species of bacteria. As the temperature falls secondary changes occur, especially the formation of lactic and acetic acids.

Modern teaching appliances in biology, by R. R. WRIGHT.

Professor Wright took this occasion to show and explain the various rooms and fittings of the new and handsome biological building in which the meetings of the section were held. All the appointments show much thought, and wise and liberal expenditure. Among the botanical appliances were Brendel and Auzoux models, Kny and Dodel-Port charts, Noll's growth apparatus, and three patterns of Leitz microscopes. In the upper story were conservatories and tanks for water plants built of granilitic cement.

On a convenient method of subjecting living cells to coloring agents, bv GEORGE L. GOODALE.

Read by title.

The following paleobotanic paper was read before the Geological Section:

On certain remarkable new fossil plants from the Erian

and Carboniferous, and on the characters and affinities of the Paleozoic gymnosperms, by Sir William Dawson.

The paper was based upon material recently discovered. Stem, leaves and fruit from the Erian of Pennsylvania serve to establish a new genus and species, Dictyocordaites Lacoi, and other unusually perfect material from the same State and from Prince Edward island enable the author to clear up several obscure points in relationship.

The Botanical Club of the A. A. A. S.

It has been the custom of the club from its inception, with possibly an interruption at the Cleveland meeting, to hold its first session on Thursday, the second day of the association. This year did not prove an exception, although both the permanent secretary of the association, in his annual circular, and the secretary of the club, in a special circular, announced the first meeting for Tuesday, the day before the opening of the association. There are good reasons why the opening session should be on Wednesday, but it is doubtful if an earlier date will ever be found practical.

Thursday, August 29.—Shortly after 9 A. M. the president, Dr. T. J. Burrill, called the club to order, the secretary, Dr. Douglas H. Campbell, and a fair number of members being present.

The opening paper was by Mr. Thomas Meehan, who described the arrangement of stamens and pistils in Hypericum Canadense, showing that the styles are entangled among the stamens from the first, and claiming this to be an arrangement for self-fertilization. Dr. E. L. Sturtevant spoke of the self-fertilization of the common garden pea, and of the failure of the English bean (Faba vulgaris) to produce many pods in American gardens, although flowering freely. Mr. David F. Day had observed that the rose acacia (Robinia hispida) bloomed freely about Buffalo, N. Y., but set few pods, and examination had shown little pollen in the anthers. He also stated that the garden variety of Œnothera biennis expands its flowers with pollen already deposited on the stigmas. Mr. F.V. Coville said that Lupinus perennis also discharges pollen in the bud, but that in this case the stigma is not at the time in a receptive condition. Dr. B. D. Halsted, in his examinations of the garden pea, had found no germinating pollen

before the flower had opened. He had experimented with barberry by covering the flowers before opening, and had obtained fruit in only about three cases in a hundred, and possibly then only through defective protection. The pollen was there, but needed insects to elevate it to the stigmas. Dr. T. J. Burrill suggested similar tests with Hypericum. Dr. W. J. Beal thought it important to note the effect upon the stock of early and late fertilization.

Mr. Meehan also read a paper on the cleistogamy of Cerastium nutans. All specimens in the Philadelphia herbarium, wherever from, appeared to be cleistogamous, as well as the plants growing about the city. Similar observations had been made by Judge Day at Buffalo, and Mr. C. F. Wheeler in Michigan. Dr. N. L. Britton spoke of the frequency of apetaly in the Caryophyllaceæ, but thought cleistogamy almost unknown. Mr. Coville had noticed that Draba verna was cleistogamous during winter in the south.

Dr. B. D. Halsted read a paper on the pollen of Pontederia cordata, which is printed in full on another page.

Dr. Halsted also described the explosiveness of the pods of the wild bean, Phaseolus diversifolius, explaining the mechanism by which it is brought about. Dr. Britton said that many other species of the genus, and especially the tropical ones, expel the seeds in the same manner. He also called attention to the fact that this plant is really P. helvolus of Linnæus, the two names being interchanged in the manuals. Mr. M. B. Waite described the projection of seeds from the pods of native violets.

Dr. Britton showed herbarium specimens of quite a number of additions to the North American flora, and made interesting remarks in relation to them.

A collection of fifty-four well prepared cultures of bacteria and moulds on agar-agar, made by Dr. Roswell Park, of Buffalo, was exhibited to the club.

Friday, August 30.—Mr. Coville read a report from the Botanical Division of the U. S. Department of Agriculture, which was referred to a committee, consisting of Messrs. Burrill, Day and Macoun. Remarks complimentary to the department were made by Drs. Burrill, Britton and others. Mr. Macoun spoke of the botanical work being done by the Canadian survey, of the fraternal feeling of Canadian botanists for those of the United States, and of their willingness to supply material to any American scientists who may be working up special orders or groups.

Dr. Britton read a paper on the occurrence of a Siberian Labiate in Canada, and exhibited dried specimens of it. The plant is *Elsholtzia cristata* Willd., and was collected by Dr. John J. Northrop on the shore of Lake Notre Dame, province of Quebec, in 1887 and 1889. It appears like an indigenous plant in its habit of growth and persistence, but is supposed to have been introduced in wheat.

Dr. Britton also spoke of the trip of Dr. Morong in South America and its expected results in adding greatly to our knowledge of the little known flora of Paraguay. Drs. Burrill and Campbell were appointed a committee to draft a resolution expressing the interest of the club in Dr. Morong's labors.

Dr. W. J. Beal gave a description of the fruiting of Mesocarpus (Pleurocarpus) from collections made at Lansing, Mich., showing both lateral and scalariform conjugation on the same plants. As this is the principal character separating the two genera, the observation appears to remove all doubt that the latter genus should be merged in the former, a change that has already been suggested. The discussion was chiefly on the significance of conjugation in general. Dr. Burrill spoke especially of the so-called conjugation of the secondary spores of Tilletia. Dr. Bessey thought this might be an obsolescent sexual act on an obsolescent mycelium. Dr. Campbell said the essential part of the sexual act is the copulation of the nuclei, already demonstrated in some Zygnemaceæ and other lower orders, and abundantly in the higher ones.

Dr. Douglas H. Campbell called attention to the chlorophyll in the embryo of Celastrus scandens, exhibiting specimens, as illustrating the formation of chlorophyll in comparative darkness. Dr. Britton alluded to the similar case of chlorophyll in the pith of Phoradendron. He also said that he had seen a Lima bean plant grown by a workman on one of the lower levels of the Dickinson iron mine in New Jersey which had reached full eight feet in height and had an abundance of chlorophyll, although its only light came from candles.

Dr. Campbell then described his methods of obtaining and staining the pollen mother-cells of Podophyllum and Allium to show nuclear division. He also spoke of the ease with which he had grown aquatic plants in the laboratory for class use by using large glass jars and only occasionally changing the water. This evoked quite an animated discus-

sion, the experience of the members of the club being quite diversified, there having been more failures apparently than successes.

Dr. J. C. Arthur described the arrangement of curtains in his laboratory, by which he considered that he had secured a better and more efficient lighting with a south exposure than is possible when the light is admitted from any other direction.

MONDAY, September 2.—As many as half the members of the club were absent on the excursion to the Muskoka lakes, but the usual meeting was held at 9 A. M. in the biological room, Prof. Bessey acting as president and Prof. Arthur as secretary *pro tem.*

The treasurer's report was read, showing a deficit of over four dollars. After some discussion it was laid on the table for subsequent action.

Mrs. Henrietta L. T. Wolcott desired to learn if the amber-colored choke-cherry occurred in Canada, as she had been told that it did. She reported the destruction, during some street improvements, of the original trees with amber-colored fruit in Dedham, Mass., which the club had heard about at former meetings, and which Dr. Sereno Watson had thought worthy of being described as a distinct variety. No one was able to give the information desired, but it was the opinion, especially of Mr. Macoun, that no such variety was known to exist in Canada.

Mr. W. H. Seaman exhibited a number of species of interesting plants gathered in the vicinity of Toronto, and also a convenient portable plant press. Quite an extended discussion arose on different forms of presses and methods of collecting. Mr. Macoun said that he and his son together had collected as many as 20,000 specimens in a season in connection with the Canadian survey. They use presses with board sides and stout straps, containing about twenty sheets of the usual drying papers. To secure good specimens in wet weather, when in camp, the dryers are held before the camp fire one by one until a pile of hot dryers is secured to which the plants are transferred from the hand press. Other papers are similarly heated, and the plants again transferred. Usually three transfers are enough to fully dry all but the thickest specimens, so that the plants collected in the forenoon may be dried during the afternoon.

The members who participated in the excursion to the lakes met at the usual hour of 9 A. M. in the upper cabin of

the steamer Nipissing on Lake Rosseau, and were called to order by the president, Dr. Burrill. In the absence of the secretary, that office was temporarily bestowed on Mr. Henry Farquhar.

Mr. Meehan reported observations on the development of the inflorescence of Corydalis sempervirens, in which the middle flowers appear first, then those above and below alternately. The discussion showed that similar behavior had been observed in other members of the same order and in the Dipsaceæ.

The vegetation of the Muskoka lakes was discussed at considerable length, specimens exhibited and several puzzling forms described. On motion of Mr. Day, Dr. Britton was appointed to prepare and publish in the *Bulletin of the Torrey Club* as complete an account as possible of the flora of the lakes.

TUESDAY, September 3.—The usual meeting was held at 9 o'clock with Dr. Burrill in the chair, and with Dr. Arthur still acting as secretary *pro tem.*

A committee on the nomination of officers for the ensuing year was appointed to consist of Messrs Day, Bessey and Coville.

The treasurer's report was then taken from the table and after some discussion was accepted. Voluntary subscriptions were then offered, amounting to $11.50, which not only canceled the indebtedness of the society, but left enough in the treasury to meet the preliminary expenses for the coming year.

The desirability of having a permanent record of the proceedings of the club in a convenient form was discussed, and it was the general opinion that such should be entered in the volume that had been procured for the purpose in compliance with the action of the club at the Cleveland meeting. The accounts as published in the *Bulletin of the Torrey Club* and the GAZETTE could be used as the basis for the previous years.

The committee appointed Friday to consider the report from the Botanical Division of the Department of Agriculture offered the following, which was heartily adopted by the club:

Having been informed of the active and encouraging work of the Botanical Division of the United States Department of Agriculture, we take great pleasure in expressing our high appreciation of the important work already accomplished and in the extensive undertakings in progress. The recognition by Congress of the importance of this botanical work, manifested by liberal appropriations of money, make possible, for

the first time in America, adequate scientific and practical researches upon native and introduced plants—in health and disease—upon which the wealth of the country so largely depends, and in which is centered the highest educational and æsthetical interests.

We heartily commend the management of this botanical division and section of vegetable pathology by those now in charge, and cheerfully express our readiness to aid them in any and every possible way.

T. J. BURRILL,
DAVID F. DAY,
Committee.

A paper was read by Prof. Joseph F. James on the value of color as a character in classification. He gave examples of its employment in such cases as Impatiens pallida and fulva, Melilotus officinalis and alba, Datura Stramonium and Tatula, Morus rubra and alba. Odor is also sometimes an important character. Dr. Britton made confirmatory remarks.

The officers for the coming year were then elected in accordance with the report of the nominating committee, as follows: President, Dr. N. L. Britton, of Columbia College; Vice-President, Prof. F. L. Scribner, of University of Tennessee; Secretary and Treasurer, Dr. Charles R. Barnes, of University of Wisconsin.

Mr. W. M. Beauchamp reported an acknowledgment from Mrs. Gray in reply to the resolutions passed by the club at the Cleveland meeting on the death of Dr. Gray.

Mr. Coville made a report on the present condition of the Botanical Exchange Club. There are twenty members. Of the forty dollars received as membership fees, there remains, after paying for printing, postage and other necessary expenses, a balance of $14.76. A considerable saving might be effected if the privilege of using the government frank could be secured in forwarding the return packages. 3,260 specimens have been received from members and 1,295 sent in return, leaving more than half still on hand. Printed copies of the rules were distributed.

The following committee report was then read and most heartily adopted:

Your committee appointed to make some expression of the interest taken by members of this club in the South American collecting trip of Dr. Thomas Morong beg leave to report as follows:

Resolved, That the compliments of the A. A. A. S. Botanical Club be sent to Dr. Thomas Morong, now making botanical collections in unexplored regions of South America, and that we tender to him an expression of our warmest interest in, and heartiest appreciation of, his arduous but highly promising labors in the new fields of his choice. We sincerely hope he may in due time return with health and strength, burdened only

by abundant success and large contributions to the known flora of the world.

T. J. Burrill,
Douglas H. Campbell,
Committee.

A committee, consisting of Messrs. Britton, Seaman and James, was appointed to draft resolutions in recognition of the courtesies received from the local committee.

The hour for the sectional meeting having now arrived, the club adjourned until the close of the morning session of the biological section.

The adjourned session was necessarily short, and time was taken only to hear the following resolutions:

Whereas, The Botanical Club of the American Association for the Advancement of Science having been most cordially and generously entertained by the citizens of Toronto; and

Whereas, The excursions tendered by the local committee of Toronto to the members of the association have been especially enjoyed by the botanical members thereof, who have been thereby enabled to visit points of botanical interest; therefore, be it

Resolved, That the Botanical Club extend their hearty thanks to the local committee for the arrangements made for their comfort and pleasure during the meeting for 1889.

Wm. H. Seaman,
N. L. Britton,
Jos. F. James,
Committee.

Resolved, That the Botanical Club of the A. A. A. S. notes with great pleasure the liberality shown by the Canadian government in providing the admirable new building and equipment for the Biological Department of the University of Toronto, and ventures to hope that at an early day the facilities here provided may be extended to include a suitable botanic garden, to which end the members of the Botanical Club pledge such assistance as may lie in their power.

Both resolutions were warmly adopted, and the club adjourned.

The sessions of the club proved much too short to hear all the papers and discuss the subjects which the members desired to bring before it, and several valuable papers were not reached.

EDITORIAL.

It was a prominent motive with the founders of the Botanical Club to make it an instrument in expanding and elevating the botanical thought of the American Association for the Advancement of Science as expressed in the papers presented before it and in the selection of botanical enterprises which it desires to foster. It was believed that if this could be accomplished to any extent, the influence would be felt in rais-

ing the standard of American botanical science as a whole. The means relied upon for accomplishing this object were (1) to create a greater feeling of fraternity among botanists and thus induce more of them to attend the meetings, (2) to make the sessions quite informal, so that every one in attendance would feel unembarrassed and at liberty to offer any bit of information that he might think of interest to his fellow workers, (3) to provide an audience for hearing such papers as are worthy of record, but because of their brevity or the relative unimportance of their conclusions would add nothing to the dignity or value of the proceedings of the biological section of the association, (4) to scrupulously refrain from permitting the club in any way to occupy or trespass upon the time or the interests rightfully belonging to the association, and (5) to keep the club intimately but unofficially connected with the association and allow no independent organization. The lines on which the club was established have been very well maintained, and the opinion of members of the association, whether botanists or not, goes to show that it has exerted a considerable influence and been reasonably successful in its aims. It is in this very element of success, in fact, that the danger to the club lies. It seems to be the common opinion outside of the club, and, we regret to say, is held by some botanists as well, that the club, having become so strong, will eventually form a section of the association. It seems to us that those holding such views do not rightly appreciate what the club is attempting to do. The idea of transforming such an excellent lever for accomplishing a good purpose into the thing to be elevated, ought to require no argument to show its want of wisdom. This journal gave some suggestions relative to the sphere of the club, in its editorial on the same subject a year ago, which it is not necessary to repeat here, although they might profitably be borne in mind by those who help in shaping the botanical features of the programme for the meetings of both the club and the association.

NOTES AND NEWS.

The American Association meets next year at Indianapolis on the third Wednesday in August.

Prof. Dr. Sadebeck has been entrusted with the administration of the Botanical Gardens at Hamburg, vice Prof. Reichenbach, deceased.

Prof. Dr. K. Prantl, of Aschaffenburg, has been nominated as the successor of Prof. Dr. Engler as Professor of Botany and Director of the Botanical Gardens of the University of Bresleau.

Prof. A. J. Cook, concludes from observation and experiment that honey is digested nectar, that when bees gather nectar very rapidly, however, some of it fails to be digested. Honey taken under such circumstances will show right hand rotation from the presence of unchanged sucrose.

MISS SUSAN M. HALLOWELL, of Wellesley College, notes and illustrates in the *American Florist* for October 1, an interesting variation in a calla (Richardia) in which a pure white but otherwise normal leaf arises from the pedicel just below and opposite the true spathe, giving the appearance of a double spathe.

THE COMMON cultivated grasses do not grow well upon the virgin soil of Nebraska, according to Prof. Bessey, but timothy (Phleum pratense) succeeds after a few years of preliminary tillage, and is the grass mostly grown, while Kentucky blue-grass also does well if a still longer interval of previous cultivation is allowed.

IN THE CELL produced directly by the zoospores of Synchytrium Taraxici the nucleus has been found of a diameter of 14μ, and the nucleolus 8μ. Shortly after this size has been attained division commences, resulting in the production of from 150 to 300 nuclei in the one cell. So says M. Dangeard, *Comptes Rendus*, cix, 1889, 202.

PROFESSOR GEORGE L. GOODALE, of Harvard University, is president of the A. A. A. S. for 1890. This is the second time in the history of the society that a botanist has filled the president's chair. Dr. Gray was the first recipient of the honor, in 1871. The vice-president of the biological section for 1890 is Dr. C. S. Minot, and the secretary, Dr. J. M. Coulter.

THE TOTAL NUMBER of papers presented at the Toronto meeting of the A. A. A. S. was 228, of which 34 came before the biological section. Twenty-two of the papers in biology were botanical, or 65 per cent., and the remaining 12 were mainly entomological. Zoölogy proper made a comparatively small showing. One might inquire if this mathematical relationship is not correlated in some manner with the establishment of biological clubs.

THE OFFICERS for the coming year of the Society for the Promotion of Agricultural Science are Prof. C. E. Bessey, of University of Nebraska, for president; Prof. W. R. Lazenby, of Ohio University, for secretary and treasurer; and Prof. T. J. Burrill, of Illinois University, for third member of the council. Thus all the officers of the society have inadvertently been filled with botanists. It is also a notable fact that one-fourth the members of the society are also botanists.

M. A. GIARD notes in the *Comptes Rendus* (cix, 1889, 324) an instance of the sterility (castration parasitaire) in Hypericum perforatum, due to the attacks of *Cecidomya hyperici* Bremi and *Erysiphe Martii* Lév. The most interesting feature of this parasitism, however, is that the insect and the fungus both produce profound changes in the general aspect of the plant, but the induced *facies* are absolutely unlike. The normal form of this species is that of an inverted cone, the lower branches being elongated and forming with the main axis a large compound corymb of flowers. Under the action of the Erysiphe, all the branches are abortive or rudimentary; the principal stem bears a few flowers, which mostly are sterile, but the leaves are very much larger than in the normal state and of a deeper green. Under the influence of the Cecidomya the form becomes that of an erect cone, the leaves become narrow, almost linear, colored externally like fruits, the parenchyma thickens, and at the edges are formed numerous black glandular points identical with those on the margins of the petals. The form thus produced resembles strongly the variety described by Jordan under the name H. microphyllum.

SAPOSCHNIKOFF finds[4] that sugar can be transformed by the leaves into starch. In his experiments he placed plants of various sorts in the dark for a time, then cut off some leaves and bisected each along the midrib. One-half was tested for starch, the other was laid for 4–18 days in a 10–20 per cent. solution of cane sugar, and then tested for starch both with iodine and by Faulenbach's method. Starch was found in abundance, especially along the veins. When the lower end of a leaf of Cordyline rubra was dipped 5 mm. in the sugar the leaf was black under the iodine test as far as 7 mm., from which point up to 10 mm. the color gradually became less deep, but extended far along the veins. In variegated leaves only the chlorophyllous cells formed starch.

THOSE who have used the paraffin-imbedding method for serial sections (see this journal for January, 1888) have doubtless wished for some simplification of the process of staining. This may be done, according to Dr. Kükenthal, by dissolving the coloring matter in absolute alcohol and dropping the solution into turpentine until the desired depth of color is secured. Sections fixed to the slide with the collodion are kept in the oven until the clove oil has completely evaporated, the paraffin dissolved in turpentine as usual, and the slide brought into the dye. The staining is quickly effected. Overstaining may be corrected by placing the slide for a short time in a mixture of acid-free absolute alcohol and turpentine (equal parts?). Turbidity of the coloring fluid may be corrected by adding a drop or two of alcohol. Meyer's carmine, methyl green, methyl-blue, gentian-violet, safranin, Bismarck-brown, eosin, fuchsin, tropæolin and malachite-green may be used in the above way.

THE SOCIETY for the Promotion of Agricultural Science held its tenth annual meeting at Toronto, August 27 and 28. Twenty-five papers were presented, of which the following are of botanical interest: J. C. Arthur, "What is common wheat rust?" the conclusion being reached that the most abundant and damaging rust of this country is not Puccinia graminis, as usually assumed, but P. rubigo-vera; W. J. Beal, "A study of bird's-eye maple," specimens of wood from maple and other trees being shown to illustrate various appearances and peculiarities of this malformation, but no conclusion regarding the cause arrived at, also "Wild grasses under cultivation," giving the result of raising the glaucous form of Elymus Virginicus from seed, only two plants out of four hundred reverting to the non-glaucous form; C. E. Bessey, "The grass problem in Nebraska," giving an account of the distribution and economic value of the most prominent native grasses, and the success attained in introducing the cultivated ones; T. J. Burrill, "A bacterial disease of Indian corn," describing an important disease chiefly affecting the roots and lower internodes; F. L. Scribner, "Grasses of mountain meadows and deer parks," among which species of Danthonia were considered the most important economically. Several other papers contained more or less botanical matter, among which were the following: Manly Miles illustrated a paper on soil metabolism by showing test-tubes said to have been etched by soil bacteria grown in nutrient material without potash; M. A. Scovell gave an account of experiments with potatoes in which blighting of the foliage was prevented by use of potash salts upon soil previously deficient in potash, the kind of blight not determined; William Saunders spoke of the comparative yield of varieties of wheat, considering each plant in the experiment individually; C. M. Weed described the treatment of potatoes with Bordeaux mixture, successfully checking the blight

[4]Berichte. d. D. bot. Gesells., vii. 258.

(Phytophthora) with four applications of half strength solution; H. W. Wiley gave analyses of sorghum seed and spoke of its comparative food value, and also of the nature of the red coloring matter of the seed and glumes. Two papers by B. D. Halsted, "The cranberry gall fungus" and "Our worst weeds," were read by title only.

IT HAS PROVED a difficult task to settle experimentally the place of the transpiration stream in plants, particularly in the herbaceous dicots and the monocots. Long ago the experiment of "ringing" the trunk of the woody plants determined that it was either in the wood body or pith that the water was conducted, and reasoning showed pretty conclusively that the pith could not have anything to do with this work. But recently Hartig and Wieler have differed widely as to what parts of the wood were most active in conduction. A long step forward in the experimental work on this function has been made by Bokorny[1] in hitting upon the use of iron sulphate. For a long time various liquids have been used in the endeavor to ascertain the rate of the transpiration stream; at first coloring matters in solution, and later salts of lithium. The difficulty with the latter is that while they can be easily detected spectroscopically in any region of the plant, it is not practicable to detect them in a tissue nor to discern whether they are in the walls or the lumen. Iron sulphate possesses the three necessary qualities of not being seized upon by any particular part of the plant, of not injuring the cells and of being easily recognized *in loco* by a simple microchemical reaction. It is used in the proportion of 1:500 or 1:1000 of distilled water, and its presence in any tissue can be detected by the use of a watery solution of ferricyanide of potassium (1:10). In general, Bokorny's results agree with the statements of Sachs (Cf. Vorlesungen über Pfl.-Phys.) except in the important particular that often tissues that are not lignified (e. g., epidermis, collenchyma, soft bast) are water-conducting, so that Sachs' insistence upon the lignification of the walls as the reason of their permeability falls to the ground. Whether in woody plants or herbs, it is the vascular bundle chiefly in which the water travels, though in some collenchyma and sclerenchyma are also conducting. In the vascular bundles it is chiefly the xylem which carries the water, sometimes the thin-walled bast. In all cases the water goes in the wall, and not in the lumen of the cell.

LEO LESQUEREUX, our most eminent bryologist and palæo-botanist, died at his home in Columbus, Ohio, on Friday, October 25th, aged almost eighty-nine years. Some years ago failing sight compelled him to give up his bryological studies, and his strength has been gradually failing. We hope to give a further account of his life and works in our next number.

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[1]Biologisches Centralblatt, ix, 1889, p. 289; Ueber den Ort der Wasserleitung in den Pflanzen.

VOL. XIV. NO. 11.—BOTANICAL GAZETTE.—NOV., 1889.

A new American Phytophthora.

ROLAND THAXTER.

The Lima beans in the vicinity of New Haven, within a radius of at least fifteen miles, have been subject during the present season to a serious disease resulting from the attack of a species of Phytophthora, quite different from the common P. infestans both in its general appearance and microscopic characters. The disease was first observed early in September, in the town of Hamden, where it was causing great damage in "truck" gardens, resulting in the destruction of a large percentage of the crop. The pods at different stages of maturity furnish the favorite point of attack, although the fungus occurs frequently on the young bean shoots, and sometimes, but more rarely, upon the leaves and petioles. On the pods it appears as a clear white felted coating, covering them entirely or forming irregular patches extending usually to both surfaces. The young shoots, although often considerably swollen and distorted, were found to contain no oospores; neither were the latter observed in any of the pods examined. The disease spreads rapidly, like its congener, and the pods, soon after the Phytophthora has appeared on any part of them, fall a ready prey to various saprophytic forms, Cladosporium, Epicoccum, etc., which complete their destruction and cause them to turn black.

The conidia are much larger than those of P. infestans and usually broader in proportion to their length. The conidiophores are also different in their appearance and mode of branching. I was unable to observe the maximum number of zoospores formed in germination; but spores of average dimensions produced from fourteen to sixteen. In a few cases a simple germinal tube was observed, but far more rarely than in P. infestans, while the production of secondary conidia as a result of lateral or terminal germination was also seen in a number of cases. The conidiophores are very commonly quite simple above their point of exit through the stomata; but more often arise two or more from a common, slightly swollen, base, above which they may be simple or once dichotomously branched. During long continued

moist weather or when kept in a damp chamber the conidiophores become indefinitely elongated and irregularly branched; but the single dichotomous form is characteristic of the species. Towards their extremities the conidiophores are furnished with the successive vesicular swellings, marking the point of proliferation from the insertion of previously formed conidia, which are characteristic of the genus.

In its large size the species approaches the European P. Cactorum; but, although I have not been able to examine specimens of this species, it seems to differ essentially from the one under consideration, both in its larger size and mode of branching. Prof. Farlow informs me that a specimen distributed in the Mycotheca Marchica on Brassica, and labelled "P. omnivora" (a form which, together with P. Fagi and P. Sempervivi, has been shown by de Bary[1] to belong to a single species, P. Cactorum) approaches the present species in its luxuriant habit; but on examination proves to be merely Peronospora parasitica.

Phytophthora Phaseoli nov. sp.

Mycelial hyphæ branched, rarely penetrating the cells of the host by irregular haustoria. Conidiophores slightly swollen at their point of exit through the stomata, arising singly or one to several in a cluster; simple or once dichotomously branched, and once to several times successively inflated below their apices. Conidia oval or elliptical, with truncate base and papillate apex; $35–50\mu \times 20–24\mu$. Germination by zoospores, usually fifteen in number, or rarely by a simple hypha of germination. Oospores unknown.

On pods, stems and leaves of the Lima bean (*Phaseolus lunatus*), New Haven, Connecticut, September and October.

New Haven, Conn.

Notes on North American Umbelliferæ. I.

JOHN M. COULTER AND J. N. ROSE.

The series of papers bearing the above title are intended to be supplementary to our *Revision of North American Umbelliferæ.*

CAUCALIS MICROCARPA H. & A. has been sent by C. R. Orcutt from Lower California.

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[1]Bot. Zeit. 1881, pp. 251–265.

CUMINUM CYMINUM L., the common "cumin" of Mediterranean countries, was found by Charles Wright, in 1852, in cultivation at El Paso, Texas. In May, 1881, Mr. J. G. Lemmon found it growing spontaneously along the banks of the Rio Grande on the island of Isleta (opposite El Paso). It is a small, slender annual 3 to 10 in. high, with long filiform leaflets and similar involucre and involucels, awl-shaped sepals, rose-colored petals, fruit with long hairs and bristles, and oil-tubes solitary under the secondary ribs. The genus is near *Trepocarpus*.

ANGELICA ARGUTA Nutt. was found in the "Coast Mountains" of Oregon, July, 1888 (*Howell* 779), and on Mt. Rainier, Washington Territory, August, 1889, at an elevation of 6,000 feet (*Piper* & *Smith* 630).

SELINUM HOOKERI Watson is sent in fine condition from near Seattle, Washington Territory, collected September, 1888 (*C. V. Piper* 631). Mr. Piper writes that it grows "just above high tide mark on the seashore." The plant attains 4 feet in height; the lower leaves are often very large, and 3 to 4-pinnate; the rays become over 1½ inch long; and the fruit is sometimes 3 or 4 lines long.

TIEDEMANNIA FENDLERI C. & R. Prof. E. L. Greene has sent some robust specimens collected along Bear Creek, Colorado, July 2, 1889, which have some of the leaves 11-foliolate, and the leaflets incisely dentate rather than "incisely serrate."

LEPTOTÆNIA ANOMALA C. & R. was collected during the past season by T. S. Brandegee, at Carbondale, California. The type specimens of this very distinct species showed fruit only and the leaves were very imperfect. The specimens of Mr. Brandegee supplement our information and enable us to complete the description. The leaves are first ternate, then pinnate into distant narrowly linear segments, and the flowers are yellow. The plant blooms in April and perfects fruit in June.

PEUCEDANUM GRAVEOLENS Benth. & Hook., the cultivated "anise" or "dill," is sent by Dr. H. E. Hasse from Los Angeles, California, where he says it is "escaped and apparently established." It is *Anethum graveolens* L., having fennel-like leaves, but the fruit of a *Peucedanum*.

PEUCEDANUM VILLOSUM Nutt. has been observed by Dr. V. Havard growing in abundance near Fort Buford, Dakota.

PEUCEDANUM AUSTINÆ C. & R. has been collected by J. G. Lemmon in Plumas county, California (no. 23). The

species seems to be well marked in fruit by the small oil-tube contained in each of the dorsal and intermediate ribs, but Mr. Lemmon's specimens show a minutely pubescent foliage. The reference to Mr. E. L. Greene's plant (Rev. Umbell. 66) should be changed so as to read Siskiyou county, 1876 (no. 732).

PEUCEDANUM MARTINDALEI C. & R., var. ANGUSTATUM C. & R., has been sent from near Ellensburg, Washington, by G. R. Vasey, August, 1889. His specimens show that the inflorescence may be somewhat puberulent as well as glabrous.

PEUCEDANUM CANBYI C. & R. has been collected by Dr. V. Havard in the Spokane River region of Washington.

Peucedanum Hassei. Tall caulescent, stout, 2 feet or more high, glabrous and somewhat glaucous, from a long slender woody root: leaves biternate, on very long petioles (sometimes as much as 10 in. including petiole); leaflets broadly ovate with wedge-shaped base, irregularly lobed, coarsely mucronate-toothed, 1 to 4 in. long, reaching 2½ in. in breadth: umbel long-peduncled, equally 8 to 18-rayed, with involucels of bractlets which vary from rather short linear-setaceous to oblanceolate, foliaceous, entire or toothed and much exceeding the rays; rays 2 to 4 in. long; pedicels 6 to 8 lines long: flowers yellow: fruit glabrous, with broad wings: oil-tubes solitary in the intervals.

Los Angeles county, California, March 27, 1888 (*Dr. H. E. Hasse*). Distributed as *Ferula Californica.*

This is an interesting addition to the *Euryptera* section on account of its tall caulescent habit, and in this respect the section character should be modified. In its general habit it bears some resemblance to *Leptotænia Californica*, but can be distinguished from that species even by its leaflet characters, while the fruit is evidently that of *Peucedanum.*

Peucedanum Torreyi. Short caulescent, 3 to 12 in. high, glabrous, slender, clothed at base with old leaf-sheaths: leaves small, ternate-pinnate or bipinnate, with very short (1 to 3 lines) linear acute-tipped segments: umbel unequally few-rayed, with involucels of 1 or 2 small bractlets or none; rays an inch long or less; pedicels a line or two long: flowers yellow; calyx-teeth small or obsolete: fruit narrowly oblong, 4 to 6 lines long, with wings not half as broad as body: oil-tubes solitary in the intervals.—Described without name in Bot. Calif. i. 263, as a plant closely allied to *Podosciadium.*

Yosemite Valley, California (*Torrey & Gray; M. K. Curran* 16, June, 1883).

This very distinct little *Peucedanum* was first collected by Drs. Torrey & Gray in immature condition. In 1883 it was rediscovered by Mrs. M. K. Curran in so much better condition that its generic relationship is evident. It is most nearly related to *P. Oreganum* and *P. Parryi* in habit and structure, but is very distinct in fruit characters, having narrower and longer fruit, unusually narrow wings, and solitary oil-tubes.

Peucedanum evittatum. Acaulescent, 8 to 18 in. high, from a deep-seated small tuber, glabrous: leaves once or twice ternate then more or less pinnate into linear callous-tipped segments (½ to 2 in. long): umbel somewhat unequally 8 to 18-rayed, with no involucre, and involucels of numerous purplish lanceolate acuminate gamophyllous bractlets; rays 1 to 2 in. long; pedicels short (1 to 1½ lines): flowers white: fruit oblong, glabrous, 4 to 5 lines long, 2½ lines broad, with very thin membranous wings more than half as broad as body, and no oil-tubes.

Ellensburg, Spokane county, Washington, May, 1889 (*G. R. Vasey*).

In the absence of oil-tubes this species is entirely different from all our known species of *Peucedanum* excepting *P. bicolor;* and it notably differs from that species in its broad thin fruit-wings and prominent gamophyllous involucels. It would properly come in the tuberous-rooted section of our *Revision*, probably nearest to *P. Canbyi*, but it contradicts the section characters, as there drawn up, in its broad fruit-wings and absence of oil tubes. Its affinities seem also to be very close with *P. bicolor*, which species it most resembles in habit.

Peucedanum Lemmoni. Caulescent, with most of the leaves near the base, 12 to 15 in. high, clothed at base with old leaf-sheaths, from an elongated rather slender root, glabrous: leaves broad triangular in outline (5 to 8 in. long including petiole), twice or thrice pinnate (or so broad as to appear at first ternate), the ultimate segments linear (1 to 2 in. long); uppermost leaves much smaller and simply pinnate: umbel 6 to 8-rayed, with no involucre, and involucels of a few almost filiform bractlets; rays short (3 to 7 lines long), making the fruits appear in a head-like cluster; pedicels a line long: flowers white (?): fruit oblong, glabrous, 2½ lines long, scarcely 2 lines broad, with thickish wings about half as

broad as body, and distinct dorsal and intermediate ribs: oil-tubes solitary in the dorsal intervals, 2 or 3 in the lateral, 4 to 6 on the commissural side: seed-face plane.

Huachuca Mountains, S. E. Arizona, June, 1887 (*Lemmon* 392).

The appearance of the leaves of this species is quite unusual for *Peucedanum*, but its affinities with that genus are clear. The specific relationship is not so clear. Mr. Lemmon writes that the plant seems very rare.

Peucedanum Plummeræ. Short caulescent with a cluster of stout widely spreading peduncles (8 to 12 in. high) rising much above the leaves and from a thick tuberous root, glabrous and somewhat glaucous: leaves ternately decompound, the numerous crowded ultimate segments very small, oblong, more or less confluent: umbel very unequally 6 to 12-rayed, with no involucre, and involucels of numerous lanceolate acuminate bractlets; rays ½ to 3 in. long; pedicels 2 to 4 lines long: flowers white: fruit oblong but usually acute at apex, glabrous, 4 to 4½ lines long, 2 to 2½ lines broad, with wings from half as broad as body to fully as broad, and indistinct dorsal and intermediate ribs: oil-tubes 2 to 3 in the intervals, 4 to 6 on the commissural side.

California, Sierra Valley, Sierra county, May, 1889, and near Shasta, Shasta county, June 28, 1889 (at both stations by *Mr. & Mrs. J. G. Lemmon*, 32 and 40).

This species seems most closely related to *P. Nevadense*.

Ligusticum scopulorum Gray. The range of this species must be extended so as to include Sierra county, California (*Lemmon* 19), and the coast mountains of Oregon (*Howell* 708).

Ligusticum Porteri C. & R. was collected in S. Utah in 1877 by Dr. E. Palmer (no. 176).

Ligusticum apiifolium Benth & Hook. has been collected in Pierce county, Oregon (*C. V. Piper* 644).

Ligusticum Grayi C. & R. was collected, August 20, 1889, by Prof. E. L. Greene, on "open ground, near timber-line, Mt. Rainier, Washington; and by Prof. John Macoun, August 5, 1889 (in flower), on "mountains north of Griffin Lake, B. C., at 6500 ft. altitude. Specimens collected on Mt. Rainier, Washington, altitude 5,000 feet (*Piper & Smith* 629) show smaller fruit than recorded before, some being but 1½ lines long; but they occur along with many of recorded size.

Ligusticum filicinum Watson was collected in great abundance near Lake City, Colorado, by E. J. Ebert, in 1888,

and in the mountains back of Denver by John Kochan in July, 1889. This is the "Osha" of the Indians, who use its very large aromatic roots. It was referred to *L. apiifolium* by Rothrock in report of Wheeler's Expedition, who collected it about Twin Lakes, Colorado.

Cœlopleurum Gmelini Ledeb. In our Revision of N. Am. Umbelliferæ (p. 90) we ventured the opinion that this species would be found along the coast of Washington Territory, and now Mr. C. V. Piper sends abundant material from near Seattle, where it grows just above high tide mark or in salt marshes on the sea-shore. The specimens are very stout, becoming 3 or 4 feet high, and the leaves are very large, the leaflets tapering at both extremities and conspicuously reticulate-veined, 2 to 4 inches long and 1 to 2 inches broad. The rays are also sometimes nearly 3½ inches long and the pedicels 4 to 8 lines. The fruit is more narrowly oblong than usual, averaging about 1½ lines in breadth by 3½ lines long. The seed soon becomes very loose in the pericarp and has a distinct lunate outline in section. The "hollow ribs" of Ledebour's description appear very prominently, and undoubtedly these specimens from Puget Sound represent more nearly those of Ledebour than any others we have seen.

Œnanthe sarmentosa Presl., as is to be inferred from the name, has a decidedly sarmentose habit. Our attention has been called to it by S. B. Parish in S. California, and by L. F. Henderson and E. L. Greene in Washington. Professor Greene describes it as follows: "The stems, though slender, are erect, but after flowering there go forth from among the umbels and upper axils long slender sterile branches which strike root at the joints or tip."

Cynosciadium pinnatum DC. Mr. F. W. Thurow has sent from Texas a large coarse form of this species 2 feet high. He has also collected this year the var. *pumilum*.

Eryngium Lemmoni. Glaucous: stem erect, branching above, 1 or 2 feet high: leaves rigid, from long oblanceolate below to broad ovate above, all sharply dentate or pinnatifid-toothed (but not pectinate), the uppermost leaves most deeply cut, teeth cuspidate-tipped: heads short-oblong (4 to 6 lines high), much surpassed and enveloped by the conspicuous involucre of broadly cuneate (becoming 4 or 5 lines broad) leaf-like cuspidate-toothed and -lobed bracts; bractlets scarcely exceeding the flowers and rather weak, the

terminal ones not at all prominent: fruit with short ovate cuspidate-tipped calyx-lobes, and long slender styles.

Chirricahua Mountains, S. E. Arizona, September, 1881 (*J. G. Lemmon* 17).

This species is most nearly allied to *E. Wrightii* Gray, but the leaves are broader and much less finely cut, and the very conspicuous involucral bracts are unlike those of any other North American *Eryngium*.

Sanicula Nevadensis Watson is sent by S. B. Parish from the San Bernardino Mountains, California, thus extending the recorded range southward. It is his no. 2085, and is said to grow on "dry ridges, 4000 ft. altitude."

Sanicula laciniata H. & A., was collected on Mt. Tamalpais, California, March 30, 1889, by Prof. E. L. Greene.

Sanicula Menziesii H. & A. has been found by C. R. Orcutt in N. Lower California, where it blooms as early as March.

Sanicula bipinnata H. & A. was collected by Mr. Thos. Howell (no. 799), April 1889, in N. California and S. Oregon, thus extending the known range of this species considerably northward. Mr. Howell's plants are lower and more bushy-branching from the base than heretofore noted. They range from 3½ to 8 in. high above ground.

Sanicula bipinnatifida Dougl. should be credited with larger fruit than given in our *Rev. Umbell.* (p. 106). Numerous specimens show fruit reaching 2 lines in length.

Fœniculum vulgare Gærtn., the "cultivated fennel," seems to be common in California. It is reported by Prof. E. L. Greene as abundant, and is also sent by Dr. H. E. Hasse from Los Angeles, where he reports it as "escaped and apparently established."

Apiastrum angustifolium Nutt. has been collected in San Diego county, California (*Orcutt*), Lower California, flowering in February (*Palmer* 643), and on Cedros Island (*Palmer* 679), all in 1889. It is the only known umbellifer on Cedros Island, where it grows "under bushes in cañons."

Musenium divaricatum Nutt. has been sent in fine condition by Dr. V. Havard from Fort Buford, Dakota, where it occurs in great abundance. We find that the seed-face may be plane as well as somewhat concave.

Musenium tenuifolium Nutt. has at last been rediscovered in fruit. In our Revision (p. 111) we stated that the fruit had been lost from the type specimens and questioned the generic relationship. Fine fruiting material has been

sent by Mr. H. J. Webber, of the Nebraska State University, who collected it in the northwestern part of Nebraska, where he says it is very common. Dr. Bessey found it at Belmont, Dawes county, early in July, and later it was collected in the same locality by Mr. Webber, who also found it quite common on high ridges in Sioux county, on Hat Creek Basin divide. Its relation to Musenium is undoubted, and Nuttall's opinion amply confirmed.

EULOPHUS BOLANDERI C. & R. is sent from Sierra county, California, by Mr. J. G. Lemmon (no. 47).

EULOPHUS PRINGLEI C. & R. was found by Mrs. R. W. Summer, at "Chalcedon Hill," San Luis Obispo, California, during the last season, "in stony open ground."

EULOPHUS PARISHII C. & R. (Rev. Umbell. 112). Abundant material of this species from C. R. Orcutt enables us to recast certain parts of the description, especially with reference to the very variable leaves: Plant becomes as much as 3 feet high: leaves ternate (rarely biternate), on petioles 2 to 5 inches long (the whole leaf, including the petiole, sometimes reaching a foot in length), with narrowly linear (almost filiform) to narrowly lanceolate leaflets (1 to 3 in. long, ½ to 5 lines wide), terminal leaflet often distant; uppermost leaves simple and bract-like: fruit 1 to 2 lines long, ½ to 1 line broad.

Cuyamaca Mountains, San Diego county, California, July 1889 (*Orcutt*), and also probably *Palmer*, in 1875, from the same county.

The range of this species is thus extended to the southern limit of California. Mr. S. B. Parish writes that he is "satisfied that all he took for *Carum Gardineri* in the San Jacinto and San Bernardino Mountains is *E. Parishii*," and pertinently raises the question whether *Carum Gairdneri* really grows in S. California. Our range for that species given in *Rev. Umbell.*, is a general one, and we have yet to see genuine *C. Gairdneri* from S. California.

Var. **Rusbyi.** Leaflets filiform to linear, becoming as much as 6 in. long; fruit larger, about 2 lines long, 1½ lines broad.

Arizona, Bill Williams Mountain, July 11, 1883 (*Rusby* 629), Flagstaff (*Lemmon*).

SCANDIX PECTEN L. is reported by Professor E. L. Greene (*Pittonia* i. 270) as naturalized in Napa Valley, California (*C. F. Sonne*). It is a low branching annual, with pinnately decompound leaves, few-rayed umbels, and a remarkably

long-beaked fruit. In fruits becoming sometimes 2 in. long, more than three-fourths of this length is occupied by the stiff flattened beak. This is the "shepherd's needle" or "Venus-comb" of Europe and W. Asia, a common weed of the fields.

Chærophyllum Anthriscus Lam., a common weed of Europe, known as "burr chervil," has been found by J. G. Lemmon growing in the streets of Alameda, California. Prof. E. L. Greene sends the same plant, having been collected at the same station by Dr. Gibbons, May, 1889. It is *Anthriscus vulgaris* Pers.

Osmorhiza brachypoda Torr. is sent by C. R. Orcutt from near Julian, San Diego county, California, collected in May, 1889, thus extending its recorded range southward. He writes that it is called "ginsheng," and is of considerable medical value.

Velæa arguta C. & R., var. **ternata.** More robust and taller (2 to 2½ feet high): leaflets larger (2 to 3 in. long) and broader, irregularly and sharply toothed, becoming more or less 3-lobed; the lowest pair with long petiolules (inch or more), giving a ternate appearance to the leaf: umbel 14 to 18-rayed.

Cuyamaca Mountains, San Diego county, California, July, 1889 (*Orcutt*): probably also *Palmer* 110a, a very immature specimen collected in 1875 in the same locality. Mr. Orcutt's specimens bring us for the first time good fruit of this species.

Sium cicutæfolium Gmelin, was collected in marshes of Lake Pend d'Oreille, Idaho, August 9, 1889, by Prof. E. L. Greene. The specimens show very dissected submersed leaves.

Carum L.—Professor E. L. Greene (*Pittonia* i. 272) has adopted the views of Hooker & Arnott in separating our Pacific species from the Old World genus under the name *Atænia*. If such a separation is possible of course this generic name is inevitable. Aside from the fact that such a separation must involve a study of the numerous Old World species, we can not discover that the autumnal habit of blooming and fruiting can be made to hold in all our species, for our collections show dates of good specimens beginning with May and ending in October. Specimens of *C. Kelloggii* just received from Prof. Greene, collected in March, show abundant and vigorous leaves, while others collected in August have flowers and fruit and mere remnants of leaves. This apparently common habit of *C. Kelloggii* is a point well taken, but until

it is proved constant for that species, and a character in common with the other species, and also supported by other characters, we can not consider it a sufficient reason for separating genera.

CARUM KELLOGGII Gray. The recorded range of this supposed rare species has been increased by its discovery in abundance in Tuolumne county, California, August, 1889 (*Lemmon* 72–74), thus extending it throughout the central part of the state, where it is known as "wild anise." Professor E. L. Greene thinks its scarcity in herbaria is due more to its late blooming and fruiting than to its actual rarity. We also have it from Mr. Lemmon from the "Oakland Hills." Some of the Tuolumne specimens showed plants 5 feet high.

CARUM OREGANUM Watson was also collected in good fruit by Mr. Lemmon in Siskiyou county, California, June, 1889.

CARUM GAIRDNERI Benth. & Hook. we have not yet seen from S. California, and would ask collectors to note whether the specimens reported from that region are not really *Eulophus Parishii*.

Carum Lemmoni. Resembling *C. Oreganum* except in the fruit, which is oblong, 1½ lines long and a line wide, with prominent calyx-teeth concealing the small stylopodium, and broad low ribs each containing a small group of strengthening cells.

"Tuolumne forest," California, August 1889, (*Lemmon* 79).

The small stylopodium and the presence of strengthening cells are characters unknown among our other species of *Carum*. In dried specimens the fruit ribs look sharp and prominent, but this is explained by the collapsed condition of the large intervening oil-tubes. After soaking, the oil-tubes become plump, and the ribs are then seen to be broad and low.

TÆNIOPLEURUM, nov. gen. Calyx-teeth prominent. Fruit oblong, glabrous, flattened laterally. Carpel with broad salient ribs, each tipped with a large group of strengthening cells. Stylopodium prominent and conical. Oil-tubes solitary in the intervals, very large, 2 on the commissural side, and a small accessory one beneath each group of strengthening cells. Seed dorsally flattened, sulcate beneath the oil-tubes, becoming loose in the pericarp and invested by a layer of secreting cells, the face plane or somewhat concave.—Smooth, erect herbs, from a fascicle of thickened fibres, with

ternate-pinnate leaves, toothed (unusually broad) leaflets, involucre and involucels of numerous and conspicuous bracts, and white flowers.

T. Howellii. Stem rather stout, 3 to 3½ feet high; leaves few, ternate then once or twice pinnate; leaflets lanceolate to ovate, strongly toothed or lobed; umbels many-rayed, with involucre of long narrowly oblanceolate bracts (becoming reflexed), and involucels of prominent lanceolate scarious-margined bractlets; rays 1½ to 2½ in. long; pedicels 3 to 5 lines long; fruit 1½ to 2 lines long.—*Carum Howellii* C. & R. Rev. Umbell. 129. *Atænia Howellii* Greene, Pittonia i. 274.

Wet places, Grant's Pass, Oregon, July, 1887, in flower; also 1888, in mature fruit (*Howell* 710).

An abundance of fine fruiting material collected by Mr. Howell has enabled us to determine the affinities of this heretofore puzzling species. In our Revision of N. Am. Umbelliferæ we hesitated to include this species under *Carum* on account of its unusual leaves and bracts, but in the absence of fruit we left the matter in doubt. Now that mature fruit has been discovered, characters are found which plainly separate it generically from *Carum*. The prominent ribs, containing large groups of strengthening cells and accessory oil-tubes, are among the most noticeable features, while the investment of the seed with an oil-secreting layer in which are frequently developed small oil-tubes, and its becoming loose in the pericarp, are perhaps no less so. When to such characters as these there are added the broad toothed leaflets and very prominent bracts of both involucre and involucels, an unusually strong combination of characters is made upon which to establish a genus. The name refers to the fact of oil-tubes being found in the ribs.

CICUTA BULBIFERA L. has at last been collected with mature fruit. It comes from Mr. O. A. Farwell, Keweenaw county, Michigan. The fruit is quite small, a line long by half a line broad, and is broadly ribbed.

BERULA ANGUSTIFOLIA Koch is sent by Prof. John Macoun, have been collected at several stations in British Columbia.

Crawfordsville, Ind.

Study of Montana Erysipheæ.

F. D. KELSEY.

In the author's experience, a wide difference exists in Montana as to the relative quantity of the *Erysipheæ* and the *Uredineæ*, the latter being by far the more numerous and on a wider range of hosts; but the *Erysipheæ*, where they do occur, are beautiful in form, abundant on the hosts, and marked in perfection of development.

ERYSIPHE LINKII Lév. Found on our prominent and abundant *Artemisia Ludoviciana* Nutt. I obtained these plants in Helena, Montana, September 17, 1888, and also in September, 1889. A careless observer would not see the fungus at all, or mistake it for particles of dust. It is evident enough in herbarium specimens, but the whole appearance of the host is such as to make it hard to see the fungus on the living plant. The identification of this species was made by Mr. E. W. D. Holway, of Decorah, Iowa, to whom the author owes a debt of gratitude for kindness and attention.

ERYSIPHE COMMUNIS (Wallr.) Fr. (1) On *Aster commutatus* Gray, September, 1888, at Helena. This host has been doubted by one eminent botanist and reaffirmed by another. If it be not A. commutatus it comes far too near to be separated into even a good variety, unless botanists are willing to multiply species. Whether the fungus be abundant can not now be told. Only once have I collected it on this host, and then obtained but a few inferior specimens. (2) On *Ranunculus Cymbalaria* Pursh. This host is an abundant one in Montana, and is most richly covered with the fungus in September and October. The host grows only a few inches in height, and always in damp places, thus inviting most genially the visits of the fungus. (3) On *Geranium Richardsoni* Fisch. & Mey. This specimen was collected at Sand Coulee by my friend, Mr. F. W. Anderson. The perithecia are very few, an unusual and possibly accidental matter. (4) On *Gutierrezia Euthamiæ* Torr. & Gray. This specimen was also found by Mr. Anderson, and its date is remarkably early, July 27, 1888. The host is but slightly affected, and no eye but that of a skilled observer would ever have seen the fungus, yet it is on both stem and leaves. (5) On *Lupinus parviflorus* Nutt. Perithecia abun-

dant and very evident, tending to greater abundance on the upper side of the leaves; development late. This specimen was collected at Deer Lodge, in October, 1888. (6) On *Œnothera albicaulis* Nutt. It develops early. The only specimen I ever saw was sent me by Mr. F. W. Anderson, collected at Sand Coulee, July 24, 1888. It is conspicuous, fairly covering some of the leaves, as on Ranunculus Cymbalaria. (7) My 1888 list calls for this fungus on *Amelanchier alnifolia* Nutt., but the paper has been lost. Some of my correspondents will have it, marked $\frac{88}{109}$. (8) This year this fungus has been remarkably abundant on *Astragalus Canadensis* L. It came early, even in August, and is still developing the last of September. Both sides of the leaflets are as black with perithecia as if painted. (9) *Ranunculus sceleratus* L. But a very small amount of this has been obtained.

Erysiphe sepulta E. & E. n. sp. This species is so named only provisionally, and may yet prove to be only an old species under peculiar circumstances. It grows on the leaves and stems of *Bigelovia graveolens* var. *albicaulis* Gray. Found in September and October and even in November, at Helena. It comes so near to E. cichoracearum that it may well be doubted if it be a new species; but the perithecia appear embedded in the woolly coat of the host. If after further study this can be proved to be a constant distinction, Ellis and Everhart will publish it as one of my new species.

ERYSIPHE CICHORACEARUM DC. (1) On *Solidago serotina* Ait. Abundant in September. Perithecia deeply colored brown and very abundant, with a most decided preference for the upper surface of the leaves. Most of my hosts are clean on the underside, revealing under the glass a perithecium here and there, but usually not to be seen with the unaided eye. (2) On *Aster lævis* L., September, 1888. Much like that on Solidago serotina. Not seen in 1889. (3) On *Bigelovia Douglasii* Gray. This host grows abundantly around Helena, yet I have never seen the fungus on any of our B. Douglasii. Mr. F. W. Anderson obtained my specimen in October 1888, on the McCarthy Mountains, near Willis. This specimen shows mycelium scarce, with comparatively abundant perithecia. Mr. Anderson marked the identification with an interrogation. Examination reveals the asci suspiciously elongated in comparison with the width; otherwise it is as E. cichoracearum. (4) On *Aster foliaceus* var. *Eatoni* Gray. Collected by Mr. F. W. Anderson on

banks of the Missouri river, September, 1888. (5) On *Artemisia Ludoviciana* Nutt. Sent by Mr. Anderson; but on examination I see no difference from the specimens of mine identified by Mr. Holway as E. Linkii. (6) On *Erigeron glabellus?* Elkhorn, Montana, September 10, 1889. The fungus was rather immature, growing on a high mountain peak, on a host too far gone for sure identification of species, but which looked like a dry season mountain form of Erigeron glabellus. (7) On *Helianthus annuus* L., Helena, September 2, 1889. The fungus covered the host on both leaf surfaces. The host grew on a damp spot along a railroad. (8) On *Helianthus Californicus* var. *Utahensis* Gray, *leg.* F. W. Anderson. Host black on both leaf surfaces with the fungus. Collected September 2, 1889. (9) On *Aster* sp., Bozeman, June 20, 1889, by Mrs. M. L. Alderson. Remarkable for its exceedingly early date. (10) On *Verbena hastata* L., Helena, September 2, 1889. Exceedingly abundant on its host, appearing first and ripening on the lower leaf surface, and then spreading to the upper. (11) On *Cnicus undulatus* var. *canescens* Gray, Helena, September 2, 1889. Abundant. When collected I took it for a Puccinia. (12) On *Stachys palustris* L., August 26, 1889, Helena. This seems, from statements in *Ill. State Lab. Bulletin* ii. art. vi., as though it ought to be E. galeopsidis, but I can not find the haustoria lobed. (13) On *Phacelia circinata* Jacq. f., Silver City, July 8, 1889. Fungus rather too immature for certainty, yet every indication is that it belongs here. I have never seen it before upon this host. It grew beside a damp meadow (14) On *Echinospermum Redowski* Lehm., July, 1889, Helena. Funguss parse and rather too young. Appeared to affect the host very materially.

Erysiphe graminis DC. Of this fungus there are two specimens in my herbarium, both obtained by Mr. Anderson in Northern Montana, one upon *Poa tenuifolia* Nutt., Sand Coulee, July, 1888; and the other upon *Agropyrum glaucum* R. & S., *leg.* F. W. Anderson, Great Falls, August, 1888.

Uncinula Salicis (DC) Winter. On *Salix flavescens* Nutt., September, 1888. Exceedingly abundant in 1888, but very scarce in 1889, possibly because of the extreme dryness this year and the early severe frosts. On *Populus tremuloides* Michx., September, 1888, it covered the leaves on the upper side. While this fungus is so common the world over, it never fails to interest the student by its beauty and abundance of perithecia. I have it from Prof. A. B. Seymour,

collected August 30, 1884, in Dakota, on *Salix flavescens;* and September 8, 1884, at Bozeman, on *Salix rostrata* Richardson.

PHYLLACTINIA SUFFULTA (Reb.) Sacc. (1) On *Cornus stolonifera* Michx., collected at Helena, September 7, 1888. Its habit is opposite to that of Uncinula, for it grows almost exclusively on the underside of leaves. A hand lens will show here and there an isolated perithecium on the upper surface, while the lower will be one mass of perithecia. (2) On *Betula* sp., Helena, October 1, 1888. The same general habit as noticed on Cornus, but not so abundant.

PODOSPHÆRA OXYCANTHÆ (DC.) DBy. On *Prunus Virginiana* L., Helena, September 17, 1888. Mycelium persistent, evident; perithecia dark brown and exceedingly abundant, sometimes almost covering the entire leaf on both sides. In 1889 no signs of it have been observed on the same trees which bore it so richly in 1888.

SPHÆROTHECA MORS-UVÆ (Schw.) B. & C. On *Ribes floridum* L., October 8, 1888. As yet this fungus on this host has proven exceedingly scarce, yet no apparent reason has been observed.

In the study of Montana fungi I would acknowledge my indebtedness to Messrs. Ellis, Holway and Anderson.

Helena, Montana.

BRIEFER ARTICLES.

The policy of the trustees of the Missouri Botanical Garden.—At a recent meeting the trustees of the garden adopted the following outline of general policy to be pursued in the development of the important institution left to their charge:

To maintain or even augment the present ornamental features of the garden.

To add to the botanical usefulness and interest of the collection by the introduction of American plants, so that, other things being equal, these shall ultimately be largely represented, and may even preponderate outside of the green-houses, giving then in the garden an epitome of the characteristics of our native flora.

To carry into execution, as rapidly as possible, a system of correctly naming and labeling all plants in the grounds with the exception of such as may be used in ribbon-gardening or for other exclusively ornamental purposes.

To provide fire-proof quarters for the invaluable herbarium of the

late Dr. George Engelmann, and to immediately mount it in the proper manner, so as to insure its preservation and availability for scientific use. Also to provide for and add to the general herbarium (based on that of Bernhardi) now at the garden, with the special object of making it complete in good representatives of American plants.

To arrange, bind, and index the books and pamphlets at the garden. Also to provide more ample, but equally safe, accommodations for the library, to bring it up to date as rapidly as possible, to enter subscriptions to periodical publications, and to keep it abreast of the times and in the most useful form by the purchase of important publications as they shall appear, and by the proper indexing of periodicals and pamphlets.

To secure a botanical museum containing material needed for study or calculated to advance general or special knowledge of botany.

To direct the main effort of research for the present toward aiding in the completion of a systematic account of the flowering plants of North America, by the publication of monographs of different orders and genera—illustrated when this may seem desirable; and to especially cultivate representatives of such groups for purposes of study.

To gradually acquire and utilize facilities for research in vegetable histology and physiology, the diseases and injuries of plants, and other branches of botany and horticulture, as special reason for developing one or the other may appear.

To make the facilities of the garden useful in botanical and horticultural instruction, as they increase and opportunity for such work appears; meantime in all feasible ways to attract to the School of Botany students of promise, and to provide for their instruction and the best use of their time as investigators.

To take steps looking to the early appointment of a number of "garden-pupils"—youths with at least an elementary English education, who shall be regarded as apprentices in the garden, working under the direction of the head gardener and foremen, and shall hold scholarships sufficient for their living expenses, together with free tuition in the School of Botany; and who, after having worked for several years in the different departments of the garden, and proved proficient in its practical work, may be admitted to examination for a certificate of proficiency in the theory and practice of gardening.

To have in mind, in appointing associates for the director, their special aptitude in some one of the branches indicated above, so that with each appointment the efficiency of the institution for instruction and original work may be broadened and increased. * * *

The fruit of Ribes aureum Pursh.—This fruit is said to be "yellowish, turning blackish." Here when fully ripe it is a bright almost orange yellow color, and does not change to darker after falling to the ground or drying on the bushes or being dried in the press. But this year I have

found a variation never before noticed here. Occasionally parties out picking berries have come home and described a new currant to me, a black currant growing with the yellow kind, and tasting the same. This "black" fruited form is not common, only a bush being found here and there, growing side by side with those bearing yellow fruit. There is, I find, an intermediate form bearing red berries. This form is usually very low (one to two and a half feet high) and "scrubby." I also find that the "black" berries are not black but a very dark red, so dark as to appear black in fully ripe berries. The plants bearing them exhibit no perceptible difference in size, mode of growth, or color and shape of foliage, and the flower and size of the fruit is the same. The contrast formed by bushes growing side by side bearing berries of these two rich colors is very striking.—F. W. ANDERSON, *Great Falls, Montana.*

Notes on Minnesota Plants.—*Geranium maculatum.* In the Mississippi valley form the leaves do not become "blotched with whitish as they grow old."

Ludwigia palustris. The manual says: "Pods not tapering at the base." In our form they are tapering. Otherwise the description agrees. I would add that the pods have eight slight wings or ridges, four green, and alternating with them four white.

Actæa alba and *A. rubra.* These two plants grow side by side on our bluffs. Being unable to see the least difference between leaves and flower clusters, I marked several spots to study the fruits. In one place I found about a dozen or more plants in one patch hardly a square yard in extent. When I looked for the fruit, part of the clusters of berries were white, part red. Is it proper to keep these two forms separate as valid species?

Cassia Chamæcrista. Our plant has all ten stamens purple, and not "four of them yellow." Furthermore, the stem here is not spreading; the plant stands rather quite erect.

Mentha Canadensis. I noticed two forms. One form has the stem nearly smooth, with minute reflexed hairs scattered; leaves rather narrow; flower clusters quite small; flowers pale, only about one-half the size of those in the next form, with green calyx; stamens with red, when old with brown included anthers, reaching barely to the base of the corolla lobes. The second form is more hairy under the hand lens; the leaves are wider; both clusters and flowers themselves are much larger, the latter more colored, with calyx tinged red; stamens long exserted, longer than the style, which is about as long, relative to the flower, as in the first form and colored, while in the first form it is almost white.

Lycopus Europæus, var. *sinuatus.* Our forms have no sterile filaments, so far as I can find, and I have examined a great many. I distinguished three forms, which showed variations that would puzzle the beginner. In one form the leaves are broad and only slightly sinuate; flower clusters small;

stamens and style about as long as the upper lip of the corolla, which is uniformly of a pale lilac. A second form has narrower, more deeply sinuate leaves; flower clusters larger; corolla on the three lobes of the lower lip irregularly spotted with purple; style well exserted, its two lobes rather longer than in the first form. A third form has leaves and flower clusters as in the second form, but the flowers have no spots on corolla, and style not exserted, but only as long as upper lobe of corolla.—JOHN M. HOLZINGER, *Winona, Minn.*

A deep-water Nostoc.—With the first gales of November and March each year there appears upon the shore of Lake Michigan an abundance of an interesting form of Nostoc. It was first observed in 1864 by Professor Oliver Marcy. Thrown out upon the shore by the waves, it appears as small brown, purple and green balls or thalli. These are not always round, but frequently ovoid, and the larger specimens broadly flattened. Generally they are globose, with a firm, tough exterior or periderm. Color varies from light blue-green and flesh-color to brown or purple, the browns prevailing. They are from 2 to 20mm. in diameter the usual size being 5mm. broad. Examined microscopically, the trichomes are thin and regular; diameter of the heterocysts, 5 to 8.75μ; average, 6.87μ; diameter of cells, 2.5 to 5.6μ; average, 3.56μ.

In 1871 specimens were sent to Harvard College, with inquiries as to its species. Dr. Gray replied, "The plant is *Nostoc sphæroides* of Kützing. Pray keep a look-out for it from year to year. It ought not to grow in deep water." This determination proved erroneous, for in Kützing's description the trichomes are said to be swollen between the heterocysts, which is not true of our Nostoc. In 1882 Professor S. A. Forbes, examining dredgings from the lake, found a Nostoc answering the general description of our lakeshore plant, and reported the same in *Science* for June 1, 1883, as *Nostoc pruniforme.* In reply to our inquiries, he said, "It was abundant all along the city front as far out as ten fathoms deep." He referred it to Dr. Wolle, who replied, "I judge rather by your description than by the samples sent that they are *Nostoc pruniforme.*" When Dr. Wolle's' "Fresh Water Algæ" appeared, this Nostoc was not mentioned. Thinking it worthy of further attention, specimens were sent to him, to Dr. Farlow, and several others. In the correspondence which followed, the plant received various names. Dr. Wolle thought it might be *N. cœruleum,* while to others it seemed to have the characteristics of *N. Zetterstedtii* and *N. verrucosum.* Dr. Farlow, having examined both the autumnal and spring stages, writes, July, 1889, "I could not make the measurements of the plant of last year agree with those of *N. pruniforme,* nor can I now, on re-examination. Dr. Barnet, however, is inclined to believe that it is really an autumnal stage of *N. pruniforme,* although it does not agree with descriptions of the type."

It should be stated further, that the base of every thallus shows a thin incrustation of calcium carbonate.

The supply along the shore at the dates mentioned is so abundant that it can be easily provided for class use in most of the laboratories of the country. This year the plant appeared with the gale of October 23, the earliest date noted, and the specimens were the largest yet found.— C. B. ATWELL, *Evanston, Ill.*

Preliminary note on the synonomy of Entothrix grande Wolle.— Two years ago, through the kindness of Rev. Francis Wolle, Bethlehem, Penn., I received specimens of his Entothrix grande. Upon a careful microscopic examination of the material I found it to be an undescribed species of *Lemanea.* I have also had an opportunity, through the courtesy of Dr. Farlow, while at his laboratory during the past summer, of verifying my observation by an examination of *Entothrix grande* Wolle, Rab. Alg. Europ. no. 2538. The species belongs to the section of the *Lamaneaceæ,* for which Sirodot[1] retained the generic name *Lemanea* Bory. The dense coil of enveloping filaments which surround the central axis of the tube, as well as the two or three layers of cells in the cortex, shows the affinity of this species with *Lemanea catenata* Kütz. and *L. nodosa* Kütz If the enveloping filaments of the central axis are carefully dissected away one could not fail to see the Lemanea structure. Mr. Wolle erred[2] also in associating it generically with Harvey's[3] *Tuomeya fluviatilis.* I have also to acknowledge the favor of Dr. Farlow in permitting me to examine type specimens of *Tuomeya fluviatilis* Harv. from Harvey's herbarium. Wolle's figure[4] of Tuomeya fluviatilis, which, by the way, he states is ideal, since he did not have an opportunity of examining specimens, bears not the slightest resemblance to the habit of the type species, which is more nearly that of *Batrachospermun moniliforme,* while it is also more nearly related to *Batrachospermum* in structure.

I hope in a forthcoming paper to give a more detailed account of the structure of Lemanea grandis than can be given here. I have arranged the synonymy as follows:

LEMANEA GRANDIS Atk.

Syn. *Entothrix grande* Wolle, Bull. Torr. Bot. Club, Nov. 1877.
Entothrix grande Wolle, Rab. Alg. Europ. 2538.
Tuomeya grande Wolle., Fresh Water Alg. U. S. pl. 66, figs. 2–8.—GEO. F. ATKINSON, *Auburn, Alabama.*

EDITORIAL.

Every botanist must rejoice at the grand provision that the late Mr. Henry Shaw has made for the promotion of botanical science in this country. As is doubtless known to every reader the largest part of Mr.

[1] Étude sur la Algues d'eau douce de la Famille *Lemaneaceæ*, Ann. d. Sci. 5th Ser. Bot. xvi, Paris, 1872.
[2] Fresh water algæ of the U. S., 1887.
[3] Nereis Bor. Am. III, pp. 66–67, Smithson. Cont. x, 1857.
[4] Fresh water algæ of the U. S., 1887.

Shaw's immense fortune (estimated from three to five millions) was left as an endowment of the botanic garden and the school of botany which have borne his name. Provision was made in the will for the administration of this trust by a self-perpetuating board of trustees. Some fear was felt that the magnificent garden would be given to the city of St. Louis, in which case there was little hope that it would prove any more helpful to scientific study than has the public garden of Boston. But the dispositions made by the will are all that could be desired, and the plans now sketched by the trustees are full of brightest promise. In such plans we unite, with all our readers, in bidding them Godspeed.

Here is the first large endowment of botanical research that this new country has seen, and the outcome will be looked for with profound interest. Of necessity, the policy of the trustees can only be outlined at this time, but we think all will agree that the lines are struck boldly on the canvas and that they indicate a most pleasing picture. Naturally the development must be slow. Such broad lines as these can not be filled in in a day or a year, but we hope that they will be steadily kept in view.

In the development of these plans the personality of the director of the garden is an important factor, as it evidently has been in their inception. The GAZETTE has rarely felt it proper to say anything personal, but it is justified in saying now that Mr. Shaw made no mistake in naming Dr. William Trelease as the first director of the Missouri Botanic Garden. The pre-eminently needed quality at this stage of the history of the garden is *many-sidedness*, and those who know Dr. Trelease best know that he fulfills this need. Not only has his training and experience been varied, but his investigations have been in several diverse fields, in each of which his contributions have been of incontestable value. The fact that he has thus been able to do valuable work in several lines, that he is a trained investigator, and that he is an experienced teacher, give him opportunity for a broad grasp of the problem of the best development of the garden that would be impossible for a narrower specialist. We sincerely hope that he will always have the earnest support of the trustees and the cordial co-operation of all botanists in every effort for the development of what, if rightly administered, must become a splendid center of botanical research.

OPEN LETTERS.

Eragrostis and Molinia.

Referring to the letter of Mr. Jared G. Smith in the September GAZETTE, I would say that the discovery of the grasses named (Melica Porteri and Eragrostis pilifera) within his state, is an interesting fact extending the northern range of these species, but I can not understand how this Eragrostis could have suggested a relationship with Molinia. I fail

to see any suggestive resemblance even in the gross appearance of the spikelets, or in the size, color, shape or texture of their glumes. But were they alike in all these particulars there are certain technical differences which at once separate them generically. E. pilifera is a true Eragrostis, of the section Eueragrostis, and its generic characters are strongly marked. The points separating Eragrostis from Molinia may thus be presented:

Eragrostis:	*Molinia:*
Rachilla continuous.	Rachilla articulate.
Flowering glumes 3-nerved, caducous; palea persistent.	Flowering glumes 5-nerved, falling off with the palea.
Hilum punctiform.	Hilum elongated linear.

Molinia is certainly related to Eragrostis and, according to the latest classification, stands next to it following Disanthelium, but the characters separating it are well marked and of such a nature as to exclude it entirely. To open Eragrostis—a genus already overburdened with species and therefore characterized with difficulty—to admit Molinia would be to destroy it.—F. LAMSON SCRIBNER, *Knoxville, Tenn.*

Freaks of roses.

An article in the September GAZETTE on "Freaks of roses," calls to mind a modification of a rose observed in a cemetery at Cape Girardeau, Mo., about a year ago. The stamens were mostly converted into petals, but the pistils were modified in a curious manner. Some had become leaves similar to those growing on the branches, while in others, half of the carpel was like half of a leaf, the other half remaining carpel-like, being curved inward and having a row of ovules on its margin. Still others had the upper half of the carpel altered to a leaf-like form, the lower half remaining like so much of a true pistil.—W. J. SPILLMAN, *Vincennes, Ind.*

CURRENT LITERATURE.

Scientific Papers of Asa Gray.[1]

THESE HANDSOME volumes form a worthy memorial of Dr Gray. The wealth of material has made Professor Sargent's task a difficult one, but it is hard to see how he could have done better. To those of us who loved this side of our great botanist these volumes are especially welcome. The nature of the man could not be expressed in the dry details of systematic work; but in his reviews, biographical sketches and essays the bright, genial master found free expression, and his keen but always kind criticism reveals much of the secret of his hold upon American botanists. The present volumes do not include the miscellaneous papers already collected by him in *Darwiniana*, or his systematic papers, but the remnant gives u 800 pages of delightful reading, really furnishing "the best account of the

[1]SARGENT, CHARLES SPRAGUE.—Scientific papers of Asa Gray, selected. Vol. I. Reviews of works on botany and related subjects (1834–1887), pp. viii. 397. Vol. II. Essays; Biographical sketches (1841–1886), pp. iv. 503. Houghton, Mifflin and Company, Boston and New York, 1889.

development of botanical literature during fifty years." His touch was particularly fine in biographical sketches, and that botanist could be counted fortunate whose memory has been embalmed in one of them. It is marvelous that he found time for so much outside work, but he seemed to turn with pleasure from the more exacting labors of a monograph to the writing of miscellaneous papers, which was his way of resting. Professor Sargent deserves our thanks for his work, and the volumes should be upon the shelves of every American botanist.

Minor Notices.

DR. GEORGE VASEY and Joseph N. Rose have published a list of the plants collected by Dr. Edward Palmer in Lower California in 1889, containing the description of thirteen new species. This is a good start in the right direction, and commends itself as one of the proper outcomes of the great collection of plants being accumulated at the National Herbarium. It is but right that the collections of so indefatigable a collector as Dr. Palmer should be carefully studied and made known to botanists. The new species include two Hosackias, a Ribes, an Aplopappus, a Senecio, a Gilia, a Phacelia, a Solanum, an Antirrhinum, a Viguiera, two Encelias and a Krynitzkia.

DR. C. C. PARRY has given additional information concerning Ceanothus, in *Proc. Davenport Acad.* v. 185-194. It was obtained chiefly by a re-exploration of certain regions on the Pacific coast. The care with which this work has been done is to be especially commended, and inspires great confidence in the result. *C. intricatus* Parry becomes a synonym of *C. sorediatus* H. & A.; *C. tomentosus* Parry is a new species to include what was formerly included under *C. sorediatus; C. Lemmoni* and *C. Orcuttii* are both new species; while *C. dentatus* T. & G. is better defined. This brings our species of Ceanothus to 33, or, including the Mexican species, 36.

A. P. MORGAN'S systematic account of N. Am. Gastromycetes has reached the second paper (Jour. Cin. Soc. Nat. Hist., April, 1889). It includes a generic table of Lycoperdaceæ (13 genera), specific descriptions under the first six (Volvatæ), and two colored plates. Two new Geasters are included, and a new genus, *Astræus*, founded upon the well-known *Geaster hygrometricus* Pers.

THE SECOND MEMOIR of the Torrey Botanical Club is a list of marine algæ of the New Jersey coast and adjacent waters of Staten Island by Isaac C. Martindale (issued Aug. 24, 1889). Lists of marine algæ are not numerous, and this contribution will undoubtedly stimulate the study of this very interesting and beautiful group. Mr. Martindale has done his work very carefully, giving full credit for his information, and rejecting what was unreliable. The list embraces 91 genera, 183 species and 41 varieties.

NOTES AND NEWS.

SPIRÆA MILLEFOLIUM Torr. is figured in *Garden and Forest*, Oct. 23.

IN THE *Jour. Trenton Nat. Hist. Soc.* (Jan., 1889), Dr. Alfred C. Stokes publishes keys to the genera of Compositæ, the species of Solidago, and the species of Aster, as described in Gray's Synoptical Flora.

MR. J. M. MACOUN, in *Garden and Forest* (October 23), gives an interesting account of Vaccinium Vitis-Idæa in its far northern haunts. There the berry is firm and juicy and very useful to man and the larger migratory birds.

LYDIA W. SHATTUCK, for over forty years teacher of botany in Mt. Holyoke Seminary, died recently at an advanced age. She was known by correspondence to many of the older botanists whose names are prominently associated with American botany.

IN THE *Kew Bulletin* for November are printed directions for collecting and preserving fleshy fungi. Dr. M. C. Cooke writes chiefly concerning such forms as the fleshy Agarics, Baleti, etc. Dr. G. Massee deals principally with the Gasteromycetes. There seems to be more danger of destroying characters by attempting too much care than from lack of it.

PROFESSOR JOHN MACOUN calls attention (*Garden and Forest*, Oct. 30) to the fine forests of Vancouver's Island, saying that they are "without exception the finest now in Canada." It seems that they are being rapidly devastated by fires started by men who are "improving" the land. It is a good opportunity for the Canadian government to enact some wise forestry laws.

COLORLESS PREPARATIONS of plants which usually turn a dark brown on being put into alcohol may be prepared, according to de Vries, by mixing with the alcohol two per cent. of acid, such as hydrochloric. It does not interfere with the microscopic investigation of such specimens, as the acid allows the alcohol to harden the cell walls and contents as usual. Several changes of alcohol may be necessary to remove all color.

DR. T. J. W. BURGESS has published a paper, read before the biological section of the Hamilton (Canada) Association, upon "the Lake Erie shore as a botanizing ground." Giving a general account of the collectors who have visited that region and its botanical peculiarities, he gives a list of 22 lost or doubtful species, and urges upon the members of the Association that they be hunted up. A list of 108 species is also given, that are restricted in Canada to the "Lake Erie District," and another list of 26 Canadian species almost restricted to the same region.

C. F. WHEELER, of Hubbardston, Michigan, has been appointed assistant in the botanical department of the Experiment Station at the Michigan Agricultural College, in place of Eugene Davenport, who has been elected Professor of Agriculture in the same institution. Mr. Wheeler will also do excellent service in other ways, by aiding to enlarge the botanical garden, museum, and herbarium. His valuable herbarium, especially rich in Michigan plants, will become the property of the college. He will spend the winter in study at the Agricultural College, and begin his duties about the last of next February.

[1] Berichte d. deutschen bot. Gesells. vii. 1889. 298.

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Flowers and Insects. III.

CHARLES ROBERTSON.

Nelumbo[1] *lutea* Planch.—The flowers are female in the first stage. On the first day the petals separate at tips, so that insects can enter and crawl about upon the carpophore and over the stigmas. At this time the anthers are indehiscent and are pressed close against the sides of the carpophore, being held in this position by the erect petals. The claw-like tips of the anthers, the only parts of the stamens now visible, form a close circle between the petals and the edge of the carpophore, thus opposing insects which might attempt to reach the pollen.

On the second day, when the petals begin to separate, insects can only reach the anthers, which are now discharging pollen, by crawling over the stigmas. Later, when the petals become widely expanded and the anthers fall upon them, insects no longer light upon the carpophore.

Delpino regards flowers of this genus as specially adapted to beetles which he supposes visit the flowers to gnaw the carpophore. I have never seen them eating this part, nor are they sufficiently abundant on the flowers to be of much use. Moreover, they remain almost stationary and seldom fly from flower to flower. Delpino has classed the flowers of Nymphæaceæ in general as *cantharophilous*, it seems to me without enough evidence. I have found Nymphæa[1] and Nelumbo visited only for pollen and Nuphar[2] both for pollen and nectar. The principal visitors are Andrenidæ, especially species of Halictus, and Syrphidæ.

Visitors (observed on 3 days between July 26 and August 12): Hymenoptera—*Apidæ:* (1) *Apis mellifica* L. ☿, c. p , ab.; (2) *Ceratina dupla* Say ♀. *Andrenidæ:* (3) *Agapostemon radiatus* Say ♀, ab.; (4) *Augochlora pura* Say ♀, ab.; (5, 6) Halictus spp. ♀, ab.; (7) *H. ligatus* Say ♀; (8) *H. Lerouxii* St. Farg. ♀ (= *parallelus* Sm.); (9) *H. parallelus* Say ♀, ab. (= *occidentalis* Cr.); (10) *H. pilosus* Sm. ♀, ab.; (11) *H. confusus* Sm. ♀, ab., all c. p.; (12) Prosopis

[1] On the fertilization of Nelumbo see Delpino: Ulteriori osservazioni sulla dicogamia nel regno vegetale; and Comes: Studii sulla impollinagione in alcune piante.

[2] BOT. GAZETTE, XIV, 122-125.

sp. ♀; (13) *P. affinis* Sm. ♀, both f. p. *Scoliidæ:* (14) *Myzine interrupta* Say; (15) *Scolia bicincta* F.

Diptera—*Syrphidæ:* (16) *Pipiza pullchella* Will. ab.; (17) *Chrysogaster nitida* Wied.; (18) *Syrphus ribesii* L.; (19) *Mesograpta marginata* Say; (20) *Sphærophoria cylindrica* Say; (21) *Syritta pipiens* L., all f. p. *Ephydridæ:* (22) *Notiphila unicolor* Lw., f. p.

Coleoptera—*Coccinellidæ:* (23) *Megilla maculata* De G.; (24) *Hippodamea 13-punctata* L. *Cerambycidæ.* (25) *Leptura plebeja* Rand. *Chrysomelidæ:* (26) *Diabrotica 12-punctata* F., ab., all f. p.

Workers of Bombus separatus, B. americanorum[3] and B. scutellaris dropped into the flowers, but immediately flew away, as if they had failed to find what they sought. I also found Bombus virginicus, Agapostemon radiatus and Lucilia cornicina dead in the flowers, where they had probably been enclosed by the petals and suffocated by the heavy odor.[4]

Dentaria laciniata Muhl.—This flower agrees in most respects with Cardamine pratensis, as described by Müller. But the nectaries which occupy the position of the two missing stamens are of nearly or quite the same importance as those surrounding the bases of the two short stamens. Accordingly the saccate bases of the sepals which hold the nectar from these glands are of about the same size as the others. The stigma commonly surpasses the anthers, so that it strikes the bee in advance of them, but there is a chance of self-pollination in absence of insects.

The erect sepals and the claws of the petals measure about 8 mm., and with the stamens and style narrow all ways of access to the nectar, so that only insects with a tongue 8 mm., or longer, can reach the nectar with perfect ease. But short-tongued bees sometimes manage to force their way in so as to reach the sweets. The flowers are white, or sometimes with a purplish tinge, and grow in rather conspicuous umbels. There are more long-tongued bees than in Müller's list of visitors of C. pratensis.

Visitors (observed on 7 days, between April 2 and 20):

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[3] *Bombus americanorum* Fabr. is our common bumble bee. For a long time it has been mixed up with *B. pennsylvanicus* De Geer, but it is a distinct species, and *B. elatus* Fabr. (Apathus? elatus) is its male. I have taken the sexes of B. pennsylvanicus in copula. I have also taken B. elatus in copula with B. americanorum. Three nests of the latter which I opened contained no male bees except B. elatus. The nest mentioned in Proc. Ent. Soc. Phil., II, 164, said to contain 6 females and 31 workers of B. pennsylvanicus and 21 males of Apathus elatus, must have belonged to B. americanorum.

[4] Delpino mentions that insects are so killed in flowers of N. speciosa.

Hymenoptera—*Apidæ:* (1) *Apis mellifica* L., s. and c. p.; (2) *Bombus separatus* Cr. ♀, s.; (3) *B. virginicus* Oliv. ♀, s; (4) *B. americanorum* F. ♀, s.; (5) *Synhalonia honesta* Cr. ♂ ♀, s.; (6) *Ceratina dupla* Say ♂ s.; (7) *Osmia lignaria* Say ♂, s.; (8) Nomada sp. ♀, s. *Andrenidæ:* (9–11) Andrena spp. ♂ ♀, s.; (12) Halictus sp. ♀, s.; (13) *H. confusus* Sm. ♀, s.; (14) *H. stultus* Cr. ♀, c. p.

Diptera—*Bombylidæ:* (15) *Bombylius fratellus* Wied. s. *Syrphidæ:* (16) *Syrphus ribesii* F.; (17) *Sphærophoria cylindrica* Say, both f. p.

Lepidoptera—*Rhopalocera:* (18) *Lycæna comyntas* Godt.; (19) *Papilio ajax* L.

At Madison, Wis., in May, Prof. Trelease found it visited by Ceratina dupla, Osmia albiventris, ♂, and Pieris rapæ.

Geranium maculatum L.[5]—The flower agrees with the larger flowered species (G. palustre and pratense) described by Müller. The five outer stamens discharge their pollen over the center of the flower, and afterwards the five inner do the same. The anthers commonly fall off before the stigma is receptive, and the power of self-fertilization is lost. I have observed that the flowers change slowly in bad weather; some of them are in the male stage for three days and others in the female stage for as long. But on warm fair days they go through both stages on the same day.

Some small insects light upon the petals and are able to reach the nectar, though they are of doubtful value, since they are by no means certain to touch the anthers and stigmas. Müller found species of Halictus especially numerous on G. palustre, and I have found several species of Andrenidæ on this plant; but the larger bees seem to be more useful.

Visitors (observed on seven days between May 1 and 21): Hymenoptera—*Apidæ:* (1) *Apis mellifica* L. ☿; (2) *Bombus vagans* Sm. ♀; (3) *B. americanorum* F. ♀; (4) *Synhalonia speciosa* Cr. ♀; (5) *Ceratina dupla* Say ♀; (6) *Osmia montana* Cr. ♂. *Andrenidæ:* (7–9) Andrena spp. ♂ ♀, s. and c. p.; (10) *Augocholora pura* Say ♀; (11) *Halictus coriaceus* Sm. ♀; (12) *H. pilosus* Sm. ♀; (13) *H. confusus* Sm. ♀..

Diptera—*Empidæ:* (14) *Empis labiata* Lw. *Syrphid* : (15) *Helophilus latifrons* Lw., f. p.

[5] See Macloskie: BOT. GAZ., IX, 157. For references to literature of pollination of Geraniaceæ see Trelease; North Am. Geraniaceæ, Mem. Bost. Soc. Nat. Hist., IV, 101. For illustration of this species see Goodale: Wild Fls., Pl. III.

Lepidoptera—*Rhopalocera:* (16) *Colias philodice* Godt. *Sphingidæ:* (17) *Hemaris thysbe* F.—all only sucking except 7–9 and 15.

At Madison, Wis., between May 13 and June 1, Prof. Trelease found as visitors: *Nomada bisignata* Say, *N. articulata* Sm., *Augochlora pura* Say, and Andrena sp., all sucking.

Impatiens[6] *fulva* Nutt.—The flowers of this species, and of the next, are male in the first stage as is well known. The anthers sift out a great quantity of pollen when struck by a bee, and the stigma is receptive after the anthers fall. Compared with I. pallida this plant shows three peculiarities which I think favor humming-birds, viz., the red color, the small landing-place, and the longer and narrower posterior sepal. The landing is about 6 mm. long and 15 mm. wide, while in I. pallida it is 12 mm. long and 25 mm. wide and forms a more convenient resting place for bees. However, the form of I. fulva so closely resembles that of I. noli-tangere, which was developed beyond the range of humming-birds, that it can hardly be explained as a result of bird selection. It originally must have had differences which led the birds to prefer it to I. pallida. There is one peculiarity, however, which may have been produced through the influence of birds, and that is the accumulation of red spots on the original ground color. I have elsewhere expressed the view that irregular bird-flowers were originally modified by bees[7] and have been usurped by birds. From its color, and from the fact that humming-birds are the principal visitors, I regard it as a bird-flower, although bees and butterflies also occur as guests.

The posterior sepal is about 22 mm. long, and its spur, which is commonly coiled upon itself, is about 10 mm.

Visitors: Birds—*Trochilidæ:* (1) *Trochilus colubris* L., ab.

Hymenoptera—*Apidæ:* (2) *Apis mellifica* L. ☿, s. and c. p. Snyder's[8] statement that it can not effect crossing is not true in my neighborhood; (3) *Bombus virginicus* Oliv. ☿, s. and c. p.; (4) *B. americanorum* F. ♂ ☿, s.; (5) *Melissodes bimaculata* Say ♀, s.; (6) *Megachile brevis* Say ♀, c. p., hangs under the anthers so as to bring her abdominal scopa in con-

[6] On the literature of the genus see Trelease: l. c., 102.

[7] Bot. Gaz. xiii. 228.

[8] Am. Nat. xiv. 126.

tact with them and only visits flowers in the male stage. *Andrenidæ:* (7) *Augochlora pura* Say ♀, c. p., works out the pollen with her jaws and front feet, not touching stigma; (8) *Halictus confusus* Sm. ♀, c. p., like no. 6.

Lepidoptera—*Rhopalocera:* (9) *Papilio troilus* L. s.

Coleoptera—*Chrysomelidæ:* (10) *Diabrotica 12-punctata* F., gnaws holes in spurred sepal.[9]

Nos. 1–5 and 8 are useful visitors, while the rest are not. Differences in the pollen-collecting habits of Bombus and Megachile are well illustrated in this case. The former receives pollen on the dorsal surface of her thorax and wipes it off with her front legs to place it in her baskets, the latter turns so as to receive it directly in her scopa. Small species of Halictus commonly visit flowers adapted to larger insects to collect pollen directly from the anthers or to glean stray grains which are scattered about the flower. In the latter case they do no harm. The Syrphidæ also often act as gleaners of stray pollen, and only do harm when they eat it directly from the anthers.

Pollen-gathering is illegitimate behavior in this flower, since it leads the bees to pay more attention to the flowers which are in the male stage. When 2 and 3 are after pollen they neglect flowers in the second stage, since they instantly perceive that the anthers have fallen. The humming-bird coming only for nectar, and being the most rapid flier, is by far the most useful visitor, and it is but natural that it should have most influence in modifying the flower.

Impatiens pallida Nutt.—The flower is "pale-yellow, sparingly dotted with brownish red." It is much larger than in I. fulva, and has a shorter (13 mm.) and broader posterior sepal and a large horizontal landing—characters which favor humble-bees. The incurved spur measures about 6 mm. Humble-bees are more abundant and more constant in their visits than in I. fulva, while humming-birds were not seen visiting the flower.

Visitors: Hymenoptera—*Apidæ:* (1) *Bombus virginicus* Oliv. ☿, s. and c. p., ab.; (2) *B. americanorum* F. ♂, s. ab.; (3) *Megachile brevis* Say ♀, c. p., behaves as with I. fulva. *Andrenidæ:* (4) Halictus sp., s., not touching anthers and stigmas.

Diptera—*Syrphidæ:* (5) *Rhingia nasica* Say, s. and f. p.,

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[9] Mutilation or perforation of the flowers of this species was recorded by Bailey: Torrey Bull. vi. 173; Trelease: ibid vii. 20; Van Ingen: Bot. Gaz. xii. 229.

not touching anthers when sucking. Several species of Syrphidæ eat pollen which is scattered on landing. Only nos. 1 and 2 are useful visitors.

Staphylea trifolia L.—Prof. W. J. Beal[10] examined the flowers of this plant and concluded "that the chances are better for cross-fertilization than otherwise." But Mr. Meehan[11] has interpreted it as adapted to self-fertilization. On the other hand, Dr. Gray[12] held that the flower is proterogynous and cross-fertilized by bees, and my observations led me to the same conclusion, while still unaware of his view. I find from Prof. Trelease's notes that he too regarded the flower as proterogynous. Newly opened flowers show a broad, three-lobed stigma nearly closing the entrance, and the still indehiscent anthers crowded under it. The surface of the stigma is always in advance of the anthers, and can hardly become thoroughly dusted with their pollen, even if it can receive enough for self-fertilization. The most that can be said is that the flower is self-fertilized in absence of insects—a very different thing from saying that it is adapted to self-fertilization. But the small number of fruit compared with the number of flowers leads me to doubt whether self-fertilization occurs, even when insects fail. Nectar is secreted by the disk surrounding the base of the ovary. The pendulous flower is about 6 mm. deep and the sepals and petals are erect and closely approximated, so that the flower has much the same form as in the gamopetalous genus Gaylussacia and has a like effect in excluding insects, although the petals are more yielding. The ovary, filaments and petals within are very hairy, and this also aids in making the honey less accessible to short tongues and in excluding small intruders. The flower thus favors long-tongued bees, although shorter-tongued insects sometimes succeed in forcing their way into the flowers far enough to reach the nectar.

Visitors (observed in five days, between April 23 and May 11): Hymenoptera—*Apidæ:* (1) *Apis mellifica* L. ☿, s. c. p., ab.; (2) *Bombus virginicus* Oliv. ♀; (3) *B. vagans* Sm. ♀; (4) *B. americanorum* F. ♀—all 3 s., ab. *Andrenidæ:* (5–8) Andrena spp. ♂ ♀, s. and c. p., ab.; (9) Halictus sp. ♀, s.; (10) *H. coriaceus* Sm. ♀, s.; (11) *Colletes inæqualis* Say ♂, s. *Vespidæ:* (12) *Vespa maculata* L. s.

[10] Am. Naturalist i. 258.
[11] Proc. Acad. Nat. Sci. Phila., 1876, 108.
[12] See Just's Bot. Jahresbericht iv. 939.

Diptera—*Empidæ:* (13) Empis sp., s. *Syrphidæ:* (14) *Eristalis flavipes* Walk., f. p.

Lepidoptera—*Rhopalocera:* (15) *Nisonides juvenalis* F. s.

Coleoptera—*Scarabacidæ:* (16) *Euphoria sepulchralis* F. f. p.

Ceanothus Americanus L.—The flowers and their pedicels are white. The stems are surmounted by many umbel-like clusters of flowers, and many stems are crowded together; so that insects are attracted for a considerable distance by what seems one large bunch of white flowers. Each hood of a petal encloses an anther, and the petal and stamen rise together. The peculiar form of the petals is associated with a peculiar disposition of the sepals, which serve to conceal the nectar, so as to limit the visitors to a more diligent set than would predominate if the nectar were more freely exposed. The nectar is secreted on a broad disk which is concealed by the sepals remaining strongly closed over it. A petal and an anther have thus to be liberated through the narrow slit between two sepals, and the form of the blade of the petal is to allow it to escape and to free the anther with it. In character of visitors the plant resembles those Umbelliferæ in which the disk is covered by the incurved petals.

Visitors (observed on five days between June 19 and 29): Hymenoptera—*Apidæ:* (1) *Bombus separatus* Cr. ♀, s. and c. p.; (2) *B. pennsylvanicus* DeG. ♀, c. p.; (3) *Ceratina dupla* Say ♂, s.; (4) *Megachile brevis* Say ♀, s. and c. p.; (5) *Heriades carinatum* Cr. ♀, s. and c. p.; (6) *Nomada incerta* Cr. ♀, s.; (7) *Calliopsis andreniformis* Sm. ♂, s. *Andrenidæ:* (8) Macropis sp. ♂, s.; (9) *Augochlora pura* Say ♀, s. and c. p.; (10) *Halictus pectoralis* Sm. ♀, s. and c. p.; (11) *H. similis* Sm. ♀, s. and c. p.; (12) *H. flavipes* F. ♀, s. and c. p,; (13) *H. confusus* Sm. ♀, s. and c. p.; (14) *H. stultus* Cr. ♀, s. and c. p.; (15) *Sphecodes confertus* Say ? ♂ ♀ s.; (16) *Prosopis affinis* Sm. ♂ ♀, s.; (17) *P. pygmaea* Cr. ♂ ♀, s. *Vespidæ:* (18) *Polistes pallipes* St. Farg. *Eumenidæ:* (19) *Eumenes fraternus* Say; (20) *Odynerus tigris* Sauss.; (21) *O. fulvipes* Sauss.; (22) *O. dorsalis* F.; (23) *O. foraminatus* Sauss.; (24) *O. conformis* Sauss.; (25) *O. pedestris* Sauss.; (26) *O. pennsylvanicus* Sauss. *Crabronidæ:* (27) *Crabro interruptus* St. Farg.; (28) *Oxybelus 4-notatus* Say; (29) *O. frontalis* Rob.; (30) *O. emarginatus* Say. *Philanthidæ:* (31, 32) Cerceris spp.; (33) *C. clypeata* Dahlb.; (34) *C. compacta* Cr.: (35) *C. compar* Cr.; (36) *C. rufinoda* Cr.

Larridæ: (37) *Larra acuta* Patton. *Sphecidæ:* (38) *Ammophila intercepta* St. Farg.; (39) *Pelopocus cementarius* Dru.; (40) *Isodontia philadelphica* St. Farg. *Pompilidæ:* (41, 42) Pompilus spp.; (43) *P. tenebrosus* Cr.; (44) *P. marginatus* Say; (45) *P. navus* Cr. *Chrysididæ:* (46) *Hedychrum violaceum* Brullé. *Chalcididæ:* (47) *Leucospis affinis* Say. *Tenthredinidæ:* (48) Atomacera sp.—all s. except no. 2.

Diptera—*Chironomidæ:* (49) Ceratopogon sp., f. p. *Mycetophilidæ:* (50) Sciara sp. *Culicidæ:* (51) sp. *Stratiomyidæ:* (52) Pachygaster sp. *Empidæ:* (53) Empis sp. *Syrphidæ:* (54) *Paragus bicolor* F.; (55) *Chrysogaster nitida* Wied.; (56) *Syrphus americanus* Wied.; (57) *Allograpta obliqua* Say; (58) *Mesograpta geminata* Say; (59) *M. marginata* Say; (60) *Sphærophoria cylindrica* Say; (61) *Tropidia mamillata* Lw.; (62) *T. quadrata* Say; (63) *Syritta pipiens* L. *Conopidæ:* (64) *Conops brachyrrhynchus* Macq.; (65) *Zodion fulvifrons* Say; (66) *Oncomyia loraria* Lw. *Tachinidæ:* (67, 68) spp.; (69) Hyalomyia sp.; (70) *Cistogaster divisa* Lw.; (71, 72) Ocyptera spp.; (73) *Jurinia smaragdina* Macq.; (74) *J. apicifera* Walk.; (75) *Cyphocera ruficanda v. d.* Wulp.; (76) Micropalpus sp.; (77) Exorista sp.; (78) Eggeria? sp.; (79) *Acroglossa hesperidarum* Will? *Sarcophagidæ:* (80, 81) Sarcophaga spp. Muscidæ: (82) sp.; (83) *Musca domestica* L.; (84) Lucilia, sp.; (85) *L. cæsar* L.; (86) *L. cornicina* F. *Anthomyidæ:* (87) Anthomyia sp.; (88) Limnophora sp. *Trypetidæ:* (89) *Trypeta humilis* Lw? *Sepsidæ:* (90) Sepsis sp. *Oscinidæ:* (91, 92) spp.; (93) Oscinis sp.—all s. or f. p.

Coleoptera—*Dermestidæ:* (94) *Cryptorhopalum hæmorrhoidale* Lec. *Elateridæ:* (95) *Limonius griseus* Beauv. *Lampyridæ:* (96) *Telephorus scitulus* Say. *Scarabæidæ:* (97) *Trichius piger* F. *Cerambycidæ:* (98) *Typocerus sinuatus* Newm. *Chrysomelidæ:* (99) *Pachybrachys atomarius* Melsh.; (100) *Diabrotica 12-punctata* F.; (101) *D. atripennis* Say. *Œdemeridæ:* (102) *Oxacis thoracica* F. *Mordellidæ:* (103) *Mordella marginata* Melsh. *Curculionidæ:* (104) Centrinus sp.; (105) *C. scutellum album* Say; (106) *C. picumnus* Hbst.

Hemiptera—*Capsidæ:* (107) *Calocoris rapidus* Say; (108) *Lygus pratensis* L. *Lygæidæ:* (109) *Lygæus turcicus* F. *Cydnidæ:* (110) *Canthophorus cinctus* P. B.—all s.

Lepidoptera—*Rhopalocera:* (111) *Thecla acadica* Edw.; (112) *T. calanus* Hübn.

Carlinville, Ill.

The station botanists at Washington.

The establishment of the experiment stations under the so-called "Hatch Act" has brought many botanists into lines of work that may run parallel in some respects, and therefore furnished the occasion for a union among these workers. Several of the station botanists were in attendance at the A. A. A. S. meeting at Toronto in August last, and one afternoon they found time to hold a meeting, with Dr. W. J. Beal in the chair, in which several station matters were considered. For example, the limitations for the several classes of station workers were discussed, and more particularly the topic: "What is the botanist's work in the station?" There are lines of work, as for instance the cross-fertilization of plants, that come quite naturally to either the skilled agriculturist, horticulturist or botanist, and must be decided by the circumstances of each particular case. The character of the station bulletin was considered, and the opinion generally prevailed that it should be founded upon observations and experiments made by the author, but should not exclude valuable matter elsewhere to be obtained. It was the sentiment of the meeting that collections should be made and exchanges encouraged, especially of specimens of plants most frequently referred to by station botanists. It was considered important that the station workers should meet at least once each year for conference, consultation, etc., and a committee was appointed to communicate with the director of the office of experiment stations upon this subject.

The following suggestions were sent by the committee:

"*Sir:* The undersigned have been appointed, at a meeting of the botanists of the experiment stations, a committee to call your attention to the desirability of urging upon officers of the stations that they send to the coming annual meeting of the association of colleges and experiment stations representatives of their working corps. We further wish to suggest that, in our opinion, such a gathering of the station workers would result in great good and that the stations might well defray all necessary expenses. May we not suggest that you urge this matter upon station officers?

"Charles E. Bessey,
"S. T. Maynard,
"T. J. Burrill,
"*Committee.*"

The following botanists were present: J. C. Arthur, W. J. Beal, C. E. Bessey, T. J. Burrill, F. V. Coville, B. E. Fernow, W. R. Lazenby, S. T. Maynard, Wm. Saunders, F. L. Scribner, B. M. Waite, C. E. Weed and the secretary, B. D. Halsted.

The Washington meeting of the Association of A. A. C. & E. S. was held on November 12–15, and several botanists were in attendance. Nothing of a botanical nature was provided for in the printed program of the convention, and there were objections raised as to the desirability of the association dividing into sections for special work, and it was not until near the close of the sessions that any provision was made for the holding of meetings of specialists. It was finally adopted that the association shall be divided into at least five committees as follows: Agriculture, Botany, Chemistry, Entomology and Horticulture. Previous to this, however, the botanists had held two meetings, making three in all. Several of the older botanists of the experiment stations, as, for example, the three B's, were unavoidably absent, the meeting coming at an unusually busy time of year.

Dr. Geo. Vasey was called to the chair and presided over the first two sessions of the botanists. After some routine work, the chairman presented a valuable paper upon the growth and future hopes of the Division of Botany of the U. S. Department of Agriculture. From a very small beginning, less than a quarter of a century ago, this division of the government service has increased in value and efficiency until now it is recognized as a great botanical center in our country, and especially so by the botanists of the experiment stations. Dr. Vasey called attention to the great need of works upon botany suitable to the territories and newer states, and stated that a small increase of his force would render it possible to supply the demand—a demand that is not likely to be met by private enterprise for a long time to come. A generous invitation was extended to the station botanists to avail themselves of the large opportunities for study offered by the Division of Botany.

After an interesting discussion upon topics suggested by Dr. Vasey's paper a committee was appointed to consider the relationship that exists between the Division of Botany and the station botanists, which committee drew up the following:

"The station botanists desire to express their hearty appreciation of the generous support afforded the Botanical

Division of the Department of Agriculture as is evidenced by the printing of the various bulletins of the division and the publication of a journal devoted to the special interests of botanists, and in view of the unequalled facilities afforded by the large amount of botanical material accumulated in the division available for the preparation of much needed monographs of important or difficult groups of plants, wish to urge upon the attention of the Secretary of Agriculture the desirability of prosecuting this special work and its early publication, both in the interest of botanical science and for the direct assistance of station botanists."—F. L. Scribner, S. M. Tracy and B. D. Halsted, committee. Professors Tracy, Coulter, Scribner and others urged the importance of both making the fullest use of the division and aiding in increasing its collections and usefulness.

A paper by Dr. Beal was next read by the secretary upon "The Province of the Botanist in the Experiment Station." The stations are new, and widely different views prevail as to the work a botanist should do. Some think the botanist, for example, should study the life-histories of parasitic fungi, but the testing of remedies belongs to the horticulturist. Others consider that the study of bacteria is most closely related to the work of the veterinarian. If the agriculturist is not able to distinguish among grasses in his experimental plots he should call in the assistance of the botanist. The botanist should cross or hybridize plants, improve grasses and other crops, and test remedies for fungus diseases. But above all, the staff of any station should work harmoniously, and this requires that plans of experiments should be submitted in detail to the whole station staff.

Dr. Coulter thought there was one of two things for the station authorities to do in securing a botanist: (1) If they know what they want done, then a man should be obtained that is a specialist in that work; or (2) if they do not, the wise way is to get a competent botanist and then let him select his work.

The question was raised: Should station botanists teach? There was a difference of opinion. Dr. Arthur, of Indiana, has a few of the more advanced botanical students in his laboratory, but the elementary instruction is done by a university professor who is not on the station staff. A paper from Dr. Bessey was closely related to the point under discussion and was read at this time. It favored the close connection of the station and the university for various reasons, but chiefly

because this arrangement was mutually helpful. Students when advanced can do some of the station work, under guidance, and thus increase the mass of facts desired by the station, while at the same time learning how to investigate. Dr. Bessey has been able to obtain much good work for bulletins in this way. The opinion prevailed that the station worker should not be burdened with large elementary classes, but a few advanced laboratory students are an advantage, especially if there are no regular assistants.

A paper was next presented by Prof. McCarthy upon seed-testing, giving results of extended experiments in this direction, accompanied by an explanation of a seed-testing pan placed on exhibition. Prof. Chester reported upon tests of seeds he had made, and was convinced that this line of work had been much neglected. Good-looking sorghum seed, for example, proved worthless, and much of the tested grass seed contained only twenty-five per cent. of good seed. Professor Scribner thought that seed-testing in itself was not proper work for the station botanist. Dr. Arthur stated that in his opinion we do not need seed-control stations in this country. Prof. McCarthy offered the following resolution: "That the chair appoint a committee of three to consider and recommend a uniform method of testing seeds and recording results." Professors Arthur, McCarthy and Chester constitute said committee, to report at the next annual meeting.

The balance of the time was occupied in individual reports of work done during the past year. Professor Galloway presented a report of the advances made in his section of vegetable pathology:

The work of the section is divided into two branches, namely: laboratory investigations and field experiments. After a subject is investigated in the laboratory, special agents in different parts of the country are selected to conduct experiments in treatment, these to be based upon the result of the laboratory work. During the present season agents have conducted field work in New Jersey, Virginia, Maryland, South Carolina, Georgia, Mississippi, Arkansas, Missouri, Wisconsin, Michigan, California; and the principal maladies under treatment were black-rot, downy mildew and anthracnose of the grape; powdery mildew, scab, rust and bitter-rot of the apple; potato-blight and rot; pear leaf-blight; quince leaf-blight; and strawberry leaf-blight, or rust, as it is more commonly called. Concerning black-rot, the result of the season's work has shown that the Bordeaux

mixture, containing from six to eight pounds of copper sulphate and from four to six pounds of lime, is the most reliable remedy. The ammoniacal carbonate of copper solution, however, promises to be fully as valuable as the last. It, moreover, is cheaper and can be applied with any ordinary nozzle. Downy mildew can easily be controlled by any of the copper remedies, the ammoniacal solution being the best under all circumstances. The experiments showed that anthracnose will develop despite the application of copper remedies. Powdery mildew of the apple has been treated with excellent results, the preparation used for this purpose being the ammoniacal carbonate solution. This experiment was carried on under Prof. Galloway's own supervision at nurseries near Baltimore, 300,000 apple seedlings being treated. Treatment of pear leaf-blight (Entomosporium) was made in the same nurseries, also in New Jersey, the results being highly satisfactory. The experiments in the treatment of apple scab were conducted by Professors Goff, of Wisconsin, and Taft, of Michigan. Early in the spring a plan of the work was drawn up and sent to both these men. Both carried on practically the same, but entirely independent, experiments, and both arrived at the same results, namely, that the scab could be controlled by any of the fungicides used; but all things considered the ammoniacal carbonate of copper solution was the cheapest, most practical and efficacious.

Other botanists spoke of their work very briefly, but the lateness of the hour made it necessary to bring the exercises to a summary close. It was voted that during the coming year a station botanists' bulletin be prepared, in which each botanist should outline the work already done or in progress, and thus facilitate coöperation whenever it is desired. Professors Halsted, Scribner and Galloway were made such a committee, after which the Botanical Committee of the Association of American Agricultural Colleges and Experiment Stations (a long name, by the way), with Professor S. M. Tracy in the chair, adjourned.

BYRON D. HALSTED, *Secretary*.

The relation of the flora to the geological formations in Lincoln county, Kentucky.

HARRY A. EVANS.

All farmers recognize the relation existing between the timber and the soil (which must result in most cases from the underlying rock), as is evident from the expressions which they use in speaking of the quality of land, such as "walnut land," "white oak land," "beech land" and "ash land," as Henry Clay called his place from the abundance of ash trees which grew upon it. This relation is constantly forced on the collector's notice, and especially is this the case where the territory collected over has a number of formations represented. In this (Lincoln) county there are some twenty formations, all but two of which are of such surface extent as to give rise to characteristic soils.

Last summer I made as complete a list as was possible of the flowering plants occuring on each of these formations, taking care to include no plant which seemed to owe its position to the elevation or moisture of any formation, rather than to the character of the soil. Similar formations in the surrounding counties were examined, and the list corrected by dropping the names of any plants which were not common to each horizon in all of its exposures. (In the case of the Chazy, Birdseye and Upper Subcarboniferous this was not done.)

From this list, thus corrected, I have tried to determine the species which prefer, or are peculiar to, each of the formations in this county. Whether the results, as given in this article, will hold good for other localities I do not know; if they do not it will show that the position of the plants here is due to some condition of exposure, elevation or moisture, and not to the character of the soil. I hope that collectors in states where the formations here given occur will test the results.

Most of the plants which are mentioned on only one formation I have never found on any other; with one exception no plant is mentioned if only a small number of specimens of it have been observed.

CHAZY.—The Chazy limestones, 225 feet in thickness, are seen in this state only on the Kentucky and Dix rivers, near the mouth of the latter. They form the base of the high

cliffs through which these streams flow at that point, and are the oldest rocks brought to view in the state. They give rise to no soil; the plants mentioned as occurring on them are found growing in crevices in the cliffs.

Silene rotundifolia Nutt.
Polygala Senega L.
Cladrastis tinctoria Raf.
Ribes Cynosbati L.
Galium trifidum L.
G. circæzans Michx.
Nemophila microcalyx Fisch. and Meyer.
Enslenia albida Nutt.
Ulmus racemosa Thomas.
Tradescantia pilosa Lehm.

BIRDSEYE.—The Birdseye is found just above the Chazy, and like it is seen only at and near the mouth of Dix river. It forms no soil; the plants mentioned are found in fissures in the rock.

Arenaria patula Michx.
Polygala Senega L.
Galium trifidum L.
Juniperus Virginiana L. Covering the cliff wherever it can get a foothold.

TRENTON.—There are four phases or divisions of the Trenton in this section: (1) at the base a siliceous clay; (2) beds of gray and dark blue limestones—the Blue Grass Beds; (3) a granular limestone, frequently nearly a sandstone; and (4) dove-colored limestones, much like the Birdseye. All of the series form excellent soils, the Blue Grass limestones giving the best in the state—the famed Blue Grass soils.

(Siliceous limestone.)

Liriodendron Tulipifera L.
Silene noctiflora L.
Hydrangea arborescens L.
Quercus alba L.
Fagus ferruginea Ait.
Stylophorum diphyllum Nutt.
Tilia Americana L.
Acer saccharinum Wang.
Gymnocladus Canadensis Lam.
Prunus serotina Ehrhart.
Geum macrophyllum Willd.
Fraxinus quadrangulata Michx.
Ulmus Americana L.
Celtis occidentalis L.
Morus rubra L
Carya sulcata Nutt.
Polygonum biflorum Ell.
Quercus Prinus L.

(Granular Limestone.—Entirely barren at the only place I have seen it in this county.)

(Upper Birdseye.)

Juniperus Virginiana L.

LOWER HUDSON RIVER.—These beds are made up of alternate layers of limestones and shales; where exposed the

latter decompose very rapidly, giving rise to an excellent soil.

Euonymus atropurpureus Jacq.	Q. imbricaria Michx.
Quercus alba L.	Trillium grandiflorum Salisb.
Q. obtusiloba Michx.	

MIDDLE HUDSON RIVER.—Composed of sandy shales and sandstones, which give rise to a soil that remains moist in the driest weather.

Liriodendron Tulipifera L.	P. dumetorum L.
Oxalis violacea L.	Euphorbia humistrata Engelm.
Cuphea viscosissima Jacq.	E. commutata Engelm.
Asclepias incarnata L.	Fagus ferruginea Ait.
Polygonum Virginianum L.	Trillium grandiflorum Salisb.

UPPER HUDSON RIVER.—These beds fall naturally into three divisions; at the base (1) a limestone (full of fossils) in thin layers, between which are layers of clay shales; this division decomposes rapidly, forming an excellent soil; (2) sandy limestones, in beds of considerable thickness; and (3) a limestone containing much earthy matter and silica.

(1. Lower Division.)

Anemone Caroliniana Walt.	Eupatorium ageratoides L.
Ranunculus muricatus L.	Aster oblongifolius Nutt.
Aquilegia Canadensis L.	Collinsia verna Nutt.
Dicentra cucullaria DC.	Fraxinus quadrangulata Michx.
D. Canadensis DC.	Celtis occidentalis L.
Corydalis flavula Raf.	Juglans cinerea L.
Dentaria multifida Muhl.	Quercus alba L.
Silene Virginica L.	Q. Prinus L. var. acuminata Michx.
Lychnis Githago L.	Trillium sessile L.
Prunus serotina Ehrhart.	

(2. Middle Division.)

Impatiens pallida Nutt.	Œnothera biennis L.
I. fulva Nutt.	Galium Aparine L.
Trifolium procumbens L.	Asclepias Cornuti Decaisne.

(3. Upper Division.)

Galium triflorum Michx.	Asclepias tuberosa L.
Eupatorium serotinum Michx.	Pilea pumila Gray.
Scrophularia nodosa L.	Pardanthus Chinensis Ker.

MEDINA.—Soft, easily pulverized, giving a sandy soil which erodes badly, and which once denuded of vegetation rarely becomes covered again.

Sassafras officinale Nees.	Q. obtusiloba Michx.
Quercus alba L.	Q. falcata Michx.

CRAB ORCHARD SHALES.—Mud shales, containing a few thin layers of limestone.

Acer rubrum L.
Negundo aceroides Moench.
Gleditschia triacanthos L.
Liquidambar Styraciflua L.
Ulmus Americana L.
Platanus occidentalis L.
Juglans nigra L.
Carya alba Nutt.
Quercus alba L.
Q. obtusiloba Michx.
Q. macrocarpa Michx.
Q. Prinus L. var. acuminata Michx.
Q. rubra L.

CORNIFEROUS.—Layers of limestone, often containing masses of silica, forming a red soil.

Hypericum perforatum L.
Acer saccharinum Wang.
Cassia Marilandica L.
C. Chamæcrista L.
Potentilla paradoxa Nutt.
Vernonia Noveboracensis Willd.
Lobelia leptostachys A. DC.
L. spicata, Lam.
Acalypha Virginica L.

BLACK SLATE.—Thin layers of slate which are somewhat bituminous. When well-drained this slate decomposes into a soil which is fair, especially where there is a leaf-mold. In places where the layers of slate are horizontal the drainage is poor, giving rise to a very wet soil.

(Level and badly drained portion.)

Polygala Curtissii Gray.
Rhexia Virginica L.
Quercus alba L.
Q. obtusiloba Michx.
Q. imbricaria Michx.
Q. rubra L.
Commelyna Cayennensis Richard.

(Well-drained portion.)

Liriodendron Tulipifera L.
Rhus glabra L.
Desmodium Dillenii Darlingt.
Lespedeza repens Torr. & Gray.
Liquidambar Styraciflua L.
Vernonia Noveboracensis Willd.
Gerardia integrifolia Gray.

LOWER SUBCARBONIFEROUS.—This formation has at its base (1) a considerable thickness of ash colored shales; (2) above these harder shales with some limestones; (3) just above the upper subcarboniferous, hard shales and sandstones.

(Lower Division.)

Ascyrum Crux-Andreæ L.
Stylosanthes elatior Swartz.
Eupatorium purpureum L.
Aster longifolius Lam.
Polymnia Uvedalia L.

(Middle and Upper Divisions.)

Eupatorium sessilifolium L.
E. perfoliatum L.
Oxydendrum arboreum DC.
Kalmia latifolia L.
Euphorbia corollata L.
Castanea vesca L.
Pinus mitis Michx.

UPPER SUBCARBONIFEROUS.—Heavy beds of limestones, found only on the highest knobs.

Hypericum nudicaule Walt.
Quercus nigra L.
Q. coccinea Wang.
Juniperus Virginiana L.

The Birdseye and Upper Birdseye, both pure limestones, are covered by cedars, to the exclusion of nearly everything else. On the Upper Subcarboniferous limestones cedar is present in large numbers, but does not attain such size as on the other formations; at every point at which I examined the Upper Subcarboniferous, if not covered with cedar, *Hypericum nudicaule* Walter is found in the greatest abundance.

The Oaks are represented by some species on most of the formations. *Quercus alba* L. is found in numbers on the Lower and Upper Hudson River Beds, and on the Medina sandstone, but seems to prefer the siliceous limestones at the base of the Trenton. *Q. obtusiloba* Michx. is found on all formations which give rise to a light or sandy soil. Excepting a few small trees on the Black Slate, *Q. imbricaria* Michx. is found only on the Lower Hudson River. So far as can be determined from observations in this county, *Q. nigra* L. and *Q. coccinea* Wang. are characteristic of the Upper Subcarboniferous.

Fagus ferruginea Ait. prefers a siliceous soil; and in Lincoln is most abundant on the siliceous limestones of the Trenton, but in the surrounding counties the beech forests are on the Middle Hudson River Beds—the "siliceous mudstones" of the old Kentucky reports.

Stanford, Ky.

EDITORIAL.

THE GAZETTE is naturally deeply interested in the success of the Agricultural Experiment Stations, because the establishing act makes such extensive provision for botanical investigation. It is because of our great interest in their work that we have ventured to express our opinion as to its direction and scope, and particularly as to the mode of presentation. It seems that some of the experiment stations think our advice

unwise—which is not surprising. It will consequently not be amiss to make our position clear.

It is certainly true that two main lines of botanical work were contemplated for the stations. One important feature is to be *original research;* the other, of equal importance, is the *diffusion* of knowledge among the practical gardeners, florists, nurserymen and farmers. The latter end may be accomplished by the publication of résumés of knowledge in particular lines. In the selection of the topics, good judgment is essential, if the publications are to meet with the favor of those who are to be benefited. Undoubtedly there are thousands of facts already known to physiologists which would be of interest and advantage to agriculturists to know. Once this is adequately done for any one subject the field will open for the carrying out of the original research which is contemplated. For no one can make a thorough study of a subject without finding out directions in which knowledge can be advanced. How many suggestions will be received and how fruitful in original work these will be will depend altogether upon the acuteness and skill of the individual. If our position so far is correct, it will be seen to necessitate the study of botanical literature, a point which we have insisted upon so often that it would be tiresome to say more.

But we must strongly insist that common honesty demands the separation of bulletins of information from bulletins of research. The latter, however, to be complete, must contain a statement of the previous knowledge, and these parts must be distinctly credited to their sources. It is hardly fair to conduct a series of experiments on ground that has already been covered by some foreign investigation and then to publish these as though the matter was new and the ideas originated with the last experimenter. But, it is urged, though the experiments have been conducted in another country, they are of little value because the plants and conditions are not identical with those of this country. Granted, for the sake of the argument; does it follow that when the experimenter publishes his results he should omit to state that the ground has already been traversed under such and such conditions, and to point out wherein the later experiments differ from the earlier ones? And if the experiments give the *same results* and point to the *same conclusions*, of what possible use is it to waste space and time in publishing the details?

If this publication of unimportant details continues with no reference to earlier literature, it will deepen the reproach of American botanical work, and will confirm the neglect with which it has to contend. Further, such work is open to the suspicion, whether true or not, that the failure to give due credit to other observers is prompted by a desire for the glory which of right belongs to others.

CURRENT LITERATURE.

Minor Notices.

MR. H. L. RUSSELL conducted a series of experiments in the winter of 1888–'89 to determine the character of bacteria in the ice of Lake Mendota, at Madison, Wis. From his paper[1] we learn that no pathological germs were present; that the freezing destroys about sixty per cent. as compared with the number found in the water; and that no relation exists between the number of germs in clear ice and snow-ice, in some cases a larger number being found in clear transparent ice than was found in any sample of snow-ice. The experiments are to be continued this winter.

MR. TH. HOLM describes[2] the mode of propagation of Hydrocotyle Americana by tuberiferous stolons, and gives an account of their structure, with references to the descriptive works where this mode of propagation is either not noticed or barely hinted at. Curiously, however, he fails to notice that in Coulter and Rose's Revision of the Umbelliferæ the occurrence of these tubers is made a specific character. The plates which accompany his paper are excellent. We hope he will carry out his intention of recording more such "notes."

IN THE *Proc. Boston Soc. Nat. Hist.* for 1889, Mr. A. B. Seymour prints a list of the fungi which he collected along the line of the N. P. R. R. at various points in 1884. One new species is described, Uromyces Alopecuri, on Alopecurus geniculatus, var. aristatus at Brainerd, Minn., and one new variety, Sorosporium Ellisii, var. occidentalis, on Andropogon furcatus at Bismarck, Dak.

NOTES AND NEWS.

DR. J. H. WAKKER, of Utrecht, has been appointed professor of botany at the dairy school at Oudshoorn, Holland.

DR. F. NOLL, assistant at Würzburg under Prof. Sachs, has been called to a professorship of botany at the University of Bonn.

DR. G. VON LAGERHEIM, attaché of the botanical laboratory of the University of Lisbon, has been called to the professorship of botany in the University of Quito.

THE GREAT book establishment of F. A. Brockhaus, in Leipzig, has issued its 1889 catalogue of second-hand botanical works. It is a classified list of over 3,400 titles, issued in four parts, which will be sent free upon request.

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[1] Preliminary observations on the bacteria of ice from Lake Mendota, Madison, Wis. Reprinted from *Medical News*, August 17, 1889. Repaged. pp. 15.

[2] Notes on Hydrocotyle Americana.—Extracted from Proc. Nat. Museum, xi. pp. 455-462, pl. xvi and xvii.

A. MUNTZ states (*Comptes Rendus*, cix. 646), as the result of a series of experiments, that the higher plants can absorb ammoniacal nitrogen directly by their roots, and that the nitrification of ammoniacal manures is not an indispensable condition to their utilization.

WHEREAS THE seedlings of most Conifers produce chlorophyll, even when grown in the dark, Molisch has recently shown that those of Gingko biloba show only traces of it under such conditions. Thus the etiolation which is exceptional among the larches, firs and pines becomes normal in the Gingko.

A GIGANTIC fig tree is described and figured in *Gardeners' Chronicle* (Oct. 26). It grows in the garden of the old Capuchin Convent at Roscoff, N. W. France. It is $2\frac{1}{2}$ feet in diameter, $3\frac{1}{2}$ feet from the ground, and the spread of branches is 80 feet. The limbs are supported on stone and wooden pillars.

IN A RECENT NUMBER of *Science* Dr. Goodale's Toronto address upon "Protoplasm" was printed in full. As it was evidently set up from the pages of the GAZETTE a reference to that fact was looked for, but in vain. The occasional abstraction of a short note without credit is not seriously objected to, but the wholesale appropriation of a leading article is somewhat bewildering. Legal rights are not referred to, but common courtesy.

DZIEWULSKI has redetermined the specific gravity of wood fibers. Those of deciduous trees vary between 1.540 and 1.560; of coniferous trees, between 1.535 and 1.555. After complete removal of the resin, however, the latter become 1.560. Curiously enough, with few exceptions, the specific gravity of the fibers from the softer deciduous trees is higher than that of the hard woods. In general the results confirm those of Sachs and Hartig.

DR. HERMANN DINGLER has lately published an elaborate monograph on the movements of the winged organs of plants. He treats the mechanics of the free fall of such winged structures, determining the rate of fall in still air. In the more perfectly developed wings the rate is from 2 to 6.5 times slower than when the organ is deprived of its wings. He distinguishes twelve types of wings, using the word in such a broad way as to include the adhering layer of air, which by reason of their small size retards the fall of spores and small seeds. Of course these types have numerous intergradations.

AERENCHYMA is the name of a tissue homologous with cork, which Dr. H. Schenck describes in *Pringsheim's Jahrbücher*, xx. 526. It occurs in marsh plants on submerged parts of the stems, arising from the phellogen usually. The cells have thin walls (not suberized) and contain protoplasm, nucleus, a large vacuole with clear cell-sap, minute leucoplasts, in some cases starch grains, but never air. They are in contact with each other only in small areas, and therefore have very large intercellular spaces which are filled with air. As the tissue develops it ruptures the epidermis and primary contex, so that the intercellular system comes into communication with the exterior by numerous pores and rifts, into which, however, the water never penetrates. The air in these spaces contains a large percentage of oxygen (30 p. c. in Lythrum salicaria) and it is safe to conclude that this tissue aids in supplying oxygen for the respiratory needs of the submerged parts of plants. In some other plants the abundant development of lenticels on the submerged parts or the formation of aërotropic roots or of pneumatodes seems to subserve the same function.

SHORTIA has long been regarded as one of the rarest plants in the North American flora. Now, however, it is known to be so common, in at least one region, that a long established vernacular name for it is in common use among the few families of mountaineers who inhabit the valleys at the headwaters of the Savannah river, where Shortia is found. Galax, the near relative of Shortia, is known almost universally to the people of the southern Alleghany Mountains as Coltsfoot, from a fancied resemblance of the leaf to that of a colt's foot The smaller leaf of Shortia, which resembles somewhat the leaf of Galax, is called "Little Coltsfoot."—*Garden and Forest.*

NORTH AMERICAN ROSES furnish a subject for Dr. G. N. Best in the *Journal of the Trenton* (N. J.) *Natural Hist. Soc.* (Jan., 1889). He considers their classification, and well expresses its difficulty by his opening sentence: "To the botanist who yearns to enrich synonymy, the roses offer at once an inviting and productive field." He recounts the sending to Sir Joseph Smith by Amos Eaton of three specimens from the same bush, two of which were referred by that distinguished botanist to two described species, and the third described as a new species. With such facts can it be wondered at that "the study of roses is in its infancy"? It may be a serious question whether there are species among roses. Dr. Best appends a classification, which is a modification of M. Crèpin's.

BOKORNY finds (*Prings. Jahrbücher*, xx. 427) that the phenomenon of "aggregation," first described by Darwin as taking place in the cells of the tentacles of Drosera when treated with a very weak solution of ammonium carbonate, is quite widespread, occurring in phanerogams and algæ of the most diverse families. It can be produced by almost any substance of a basic nature. He distinguishes four modes of aggregation, (*a*) contraction of the entire plasma, (*b*) contraction and division of the vacuole wall or tonoplast, (*c*) the extrusion of minute droplets of proteids from the cell-sap and their fusion into larger masses, and (*d*) similar separation of the proteids of the plasma. These forms of aggregation do not usually occur singly in any cell, and probably depend on the transition of the proteids from a swollen condition to a denser, on account of a loss of water induced by the basic substance. As to the biological significance of the phenomenon, he ventures no opinion.

THE DEATH is announced of Mr. John Ball, the distinguished English botanist. His studies were devoted largely to botanical geography and to philosophical questions relating to the origin and descent of existing floras. Mr. Ball's best known works are "The origin of the Flora of the European Alps," published in 1878, and his "Contributions to the Flora of the Peruvian Andes, with remarks on the history and origin of the Andean Flora," published in 1885, in the journal of the Linnæan Society. He accompanied Sir Joseph Hooker, in 1871, in his scientific mission to Morocco, publishing on his return a catalogue of the plants discovered, with critical introductory observations (his first attempt to explore the chain of the Greater Atlas was made as early as 1851). Mr. Ball traveled extensively and was a practiced and accurate observer, and one of the very best books of recent travels is the one in which he described his South American journey, which carried him around that continent. Mr. Ball was in North America in 1884 at the meeting of the British Association at Montreal, and of the American Association at Philadelphia, later, accompanying his old friend and correspondent, Dr. Asa Gray, on the last journey the Cambridge professor made to Roan Mountain and other points of botanical interest in North Carolina. Mr. Ball belonged to a school of botanists of which only a few members remain; and he was almost the last of his associates and contemporaries.—*Garden and Forest.*

IN AN EXTENSIVE paper on the chlorophyll-free humus plants and their biological and anatomical relations (*Prings. Jahrbücher*, xx. 475) Dr. Friedrich Johow gives first an account of the geographical distribution of the 43 phanerogamic genera and 162 species. They are essentially plants of the tropics, 121 species belonging to these regions, about 55 of these occurring in tropical America. One is found in antarctic America; about 25 in North America. After giving an account of the habitat, habit and gross anatomy, the anatomical peculiarities are discussed. Naturally the most aberrant organ is the root. On the roots of all holosaprophytes, with one exception, root-hairs are wanting. The cortex is strongly developed. The central cylinder differs from most roots in the altered grouping of the xylem and phloëm regions, the reduction of the vascular portion, or the incomplete differentiation of the procambium elements. The roots almost without exception are associated with a fungus, producing the mycorhiza of Frank. The epidermis of the shoot of all holosaprophytes, with the exception of Epipogum aphyllum, shows *no stomata*, and the cortical parenchyma has small intercellular spaces or none. The mechanical system of the stem is represented only by a simple sclerotic ring outside the vascular bundle. The paper closes with an account of the embryology of the various orders. In all the embryo of the very small seeds is extremely rudimentary. In one case the endosperm consists of three cells and the embryo of three!

THE WESTERN SOCIETY of Naturalists held its second annual meeting at Madison, Wisconsin, October 23 and 24. There were fewer in attendance than at the first meeting, but the sessions were of marked interest. The botanical papers presented were as follows: J. C. Arthur, Laboratory facilities for the study of physiology; C. E. Bessey, What to do with a beginner in botany; E. A. Birge, Elementary bacteriology in general college courses; C. R. Barnes, Recent methods in embryology and histology. The President's address was delivered on Wednesday evening on the topic, The method of multiple working hypotheses in investigation, instruction and citizenship. After the address an exhibition of the powers and adaptability of the Wright & Newton electric microscope for the projection of microscopic sections of rocks, minerals, plants and animals was given in the geological lecture room. A section of the fibrovascular bundle of the pumpkin was shown under a magnification of about 10,000 diameters, the large pitted vessels appearing about three feet in diameter. Nuclei of the root tip of the bean were shown three inches in diameter. The constitution was amended so as to bring the annual meeting hereafter in November, instead of October. Purdue University, La Fayette, Indiana, was selected as the next place of meeting, with Dr. C. E. Bessey as president, and Dr. J. S. Kingsley as secretary. The afternoon of Thursday was devoted by members to the inspection of the laboratories and museums of the University.

DR. ADAM PRAZMOWSKI summarizes in the *Biologisches Centralblatt* (ix, 417) his recent results in the study of the root tubercles of the Leguminosæ. The chief points may be stated thus: The tubercles are not normal structures but are due to the infection of the very young rootlets with bacteria. These bacteria may be obtained in pure cultures from the young roots and may be cultivated in nutritive solutions to thousands of generations. They show no diminution of their power under such cultivation. If the root is not infected when very young it remains to the end of its life free from the tubercles. The bacteria penetrate the cell wall of the root hairs and epidermis, and multiply therein

at the cost of their contents. When they have multiplied to large numbers in the root hair they accumulate near the apex of the hair as a tubular conglomerate of colonies which surround themselves with a thick membrane. After a time of development this structure grows toward the base of the root hair like a hypha-tube, and from this time on behaves like a true hyphal fungus. The tube has the thick, refractive membrane on the outside, and is densely filled with bacteria inside. It penetrates to the interior of the rootlet and induces the abnormal development of certain tissues, resulting in the formation of a tubercle. After the tissues of the tubercle have differentiated part of the tubes are dissolved and the bacteria set free, while part remain. The free bacteria multiply freely and take on a somewhat different form (forked) when they constitute the well-known "bacteroids." As to the rôle of the bacteria in the life of the plant, the author agrees with Hellriegel, that they enable the plant to obtain nitrogen, but whether this is taken in the form of compounds or from the free nitrogen of the air, he is not prepared to say. The remaining life history of the bacteria has also been worked out by the author, but we can not go further into details. The summary is a most interesting contribution to this important controversy.

IT IS STARTLING to compare a past in which botany was regarded as a subject which might be tacked on anywhere, with its present condition, in which there is scarcely a seat of learning in the three kingdoms which is not turning out serious work. But it would be a mistake to suppose that English modern botany has developed a character of its own in which the indirect influence of Darwin's later work can be not indistinctly traced. Darwin by his researches on insectivorous plants and plant movements from a purely biological point of view, prepared the way for this. Gardiner followed with a masterly demonstration of the physical continuity of protoplasm in plant tissues. Mr. F. Darwin has started what is virtually a new conception of the process of growth. On the whole, English botanists have shown a marked disposition to see in the study of protoplasm the real key to the interpretation of the phenomena of plant life. The complete analogy between the processes of secretion in animals and vegetables, established by Gardiner, and the essential part played by ferments in vegetable nutrition, illustrated by Green, are examples of the results of this line of inquiry.—*Nature.*

GENERAL INDEX.

Names of new species are printed in **Bold-Face** type; synonyms in *Italics*; * signifies death.

D

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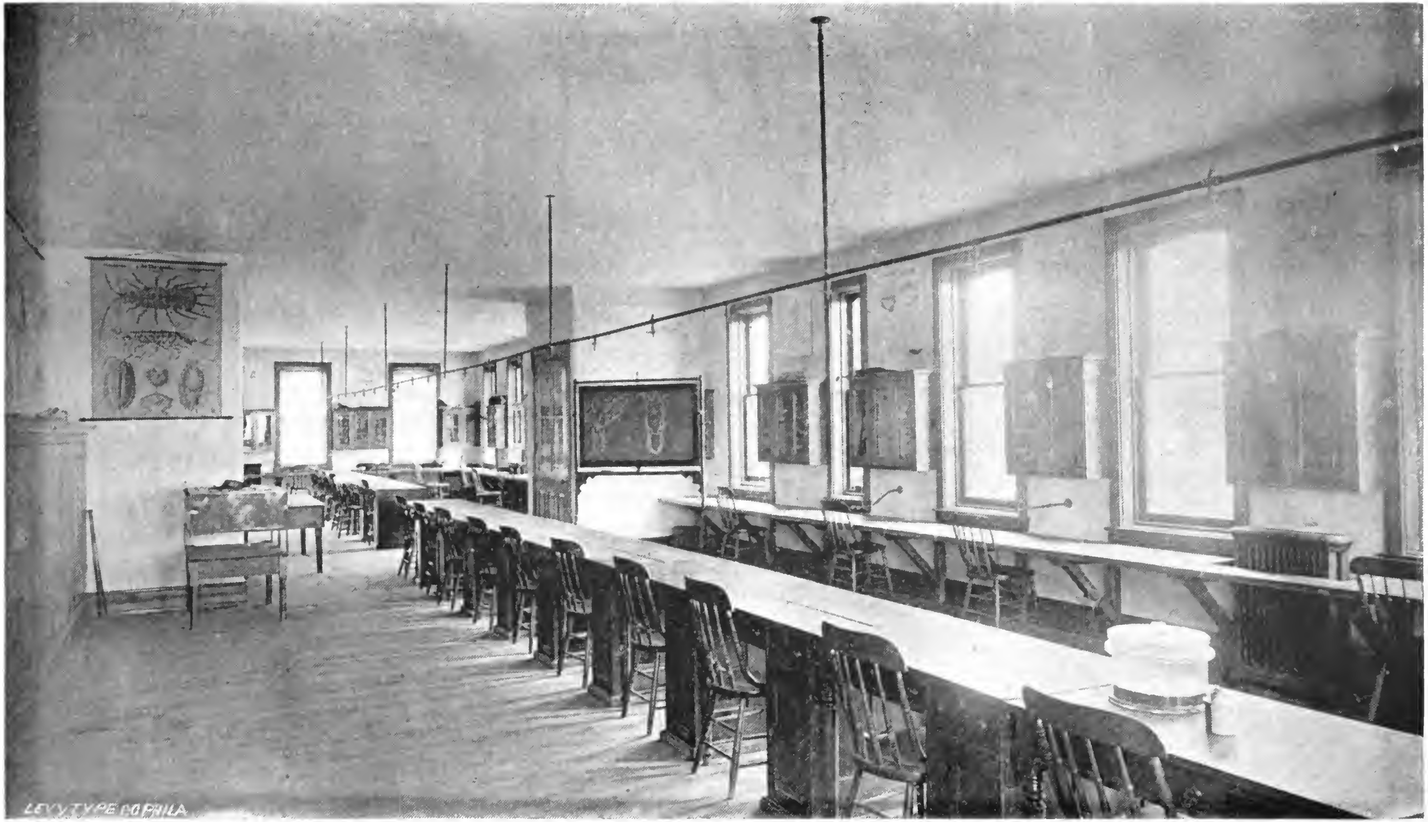
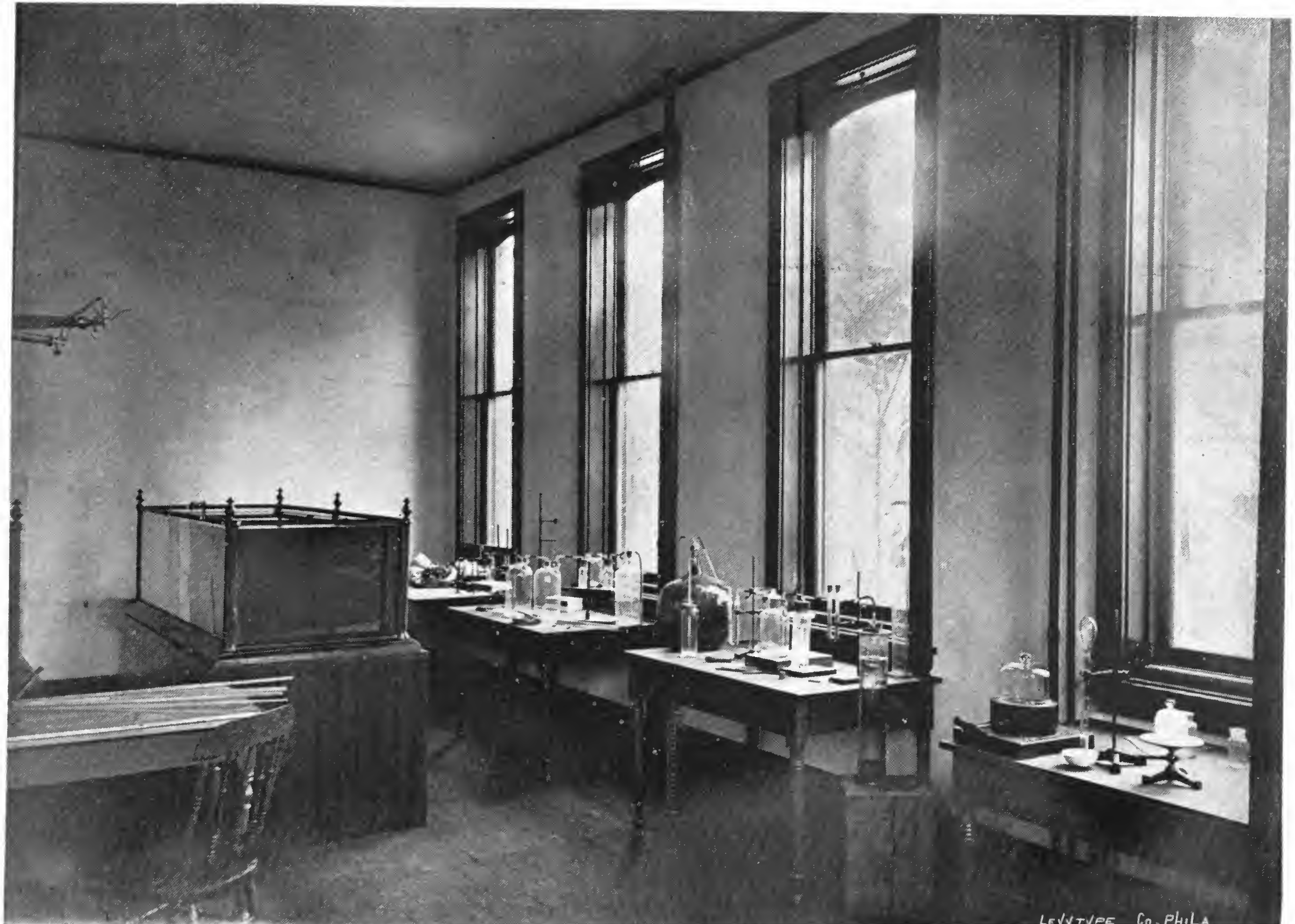
F

INDEX OF AUTHORS.

BIOLOGICAL LABORATORY.



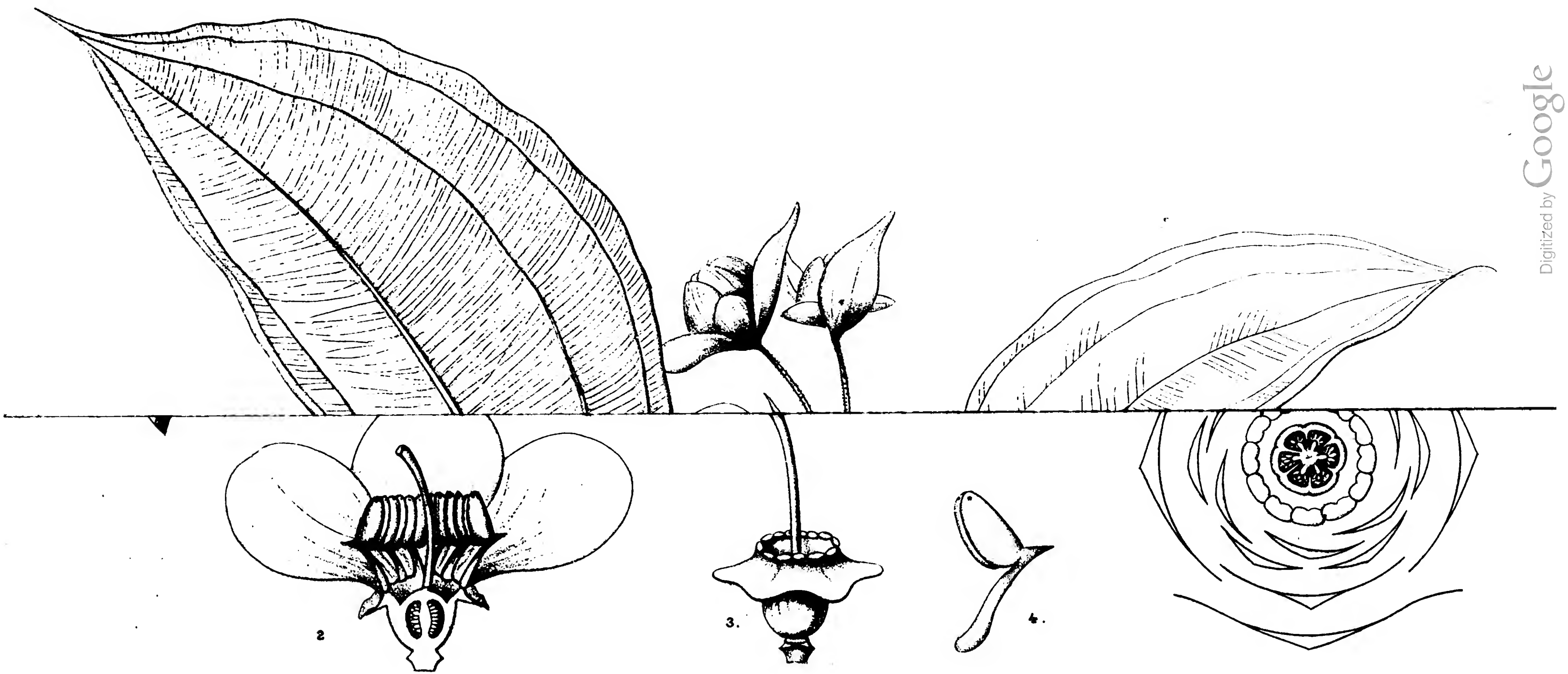
LABORATORY OF GENERAL BIOLOGY, FROM THE EAST.



IN THE PHYSIOLOGICAL LABORATORY.

IN THE GREENHOUSE.

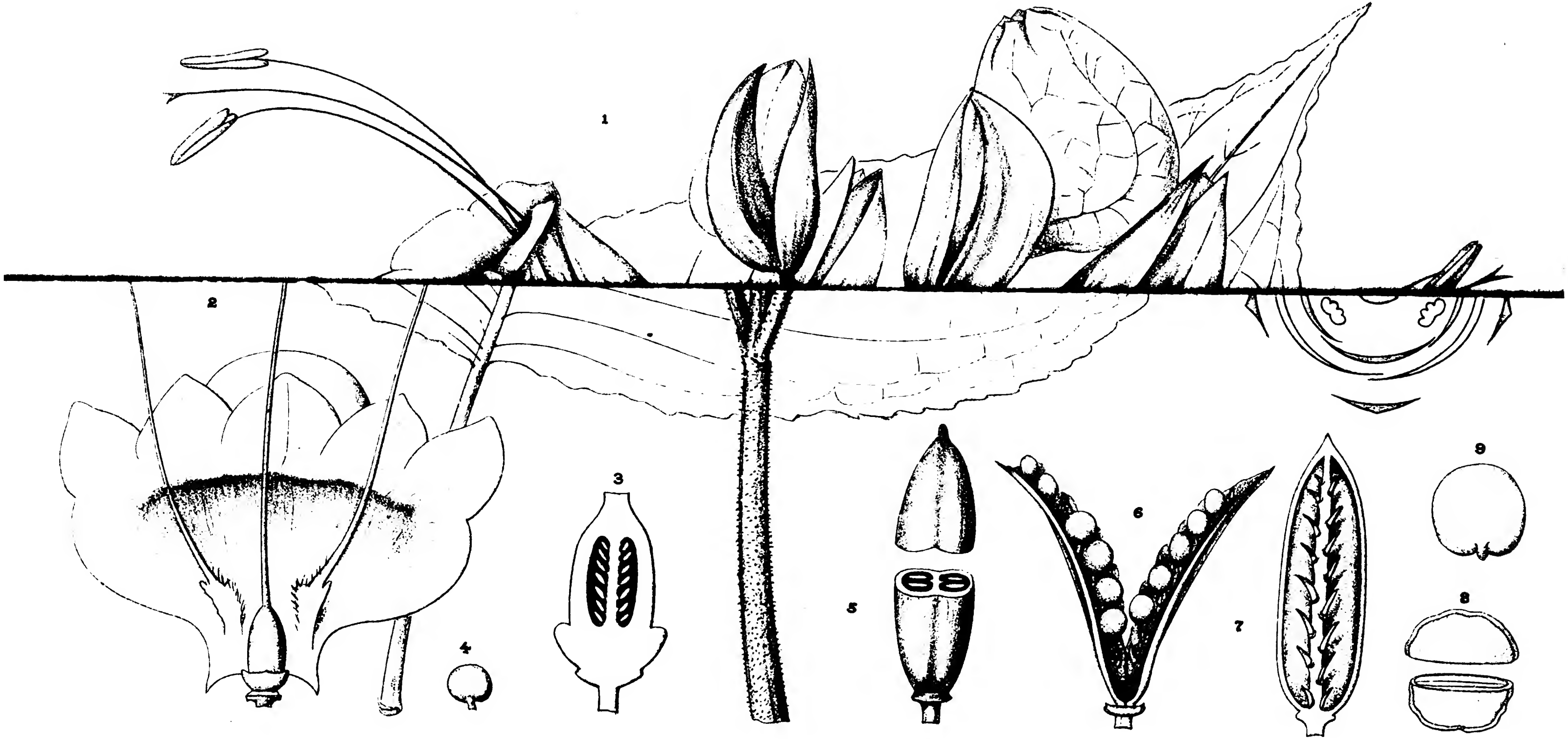
A SPECIAL LABORATORY AND PROFESSOR'S ROOM.



C. E. Faxon, del.

B. Meisel, Lith. Boston.

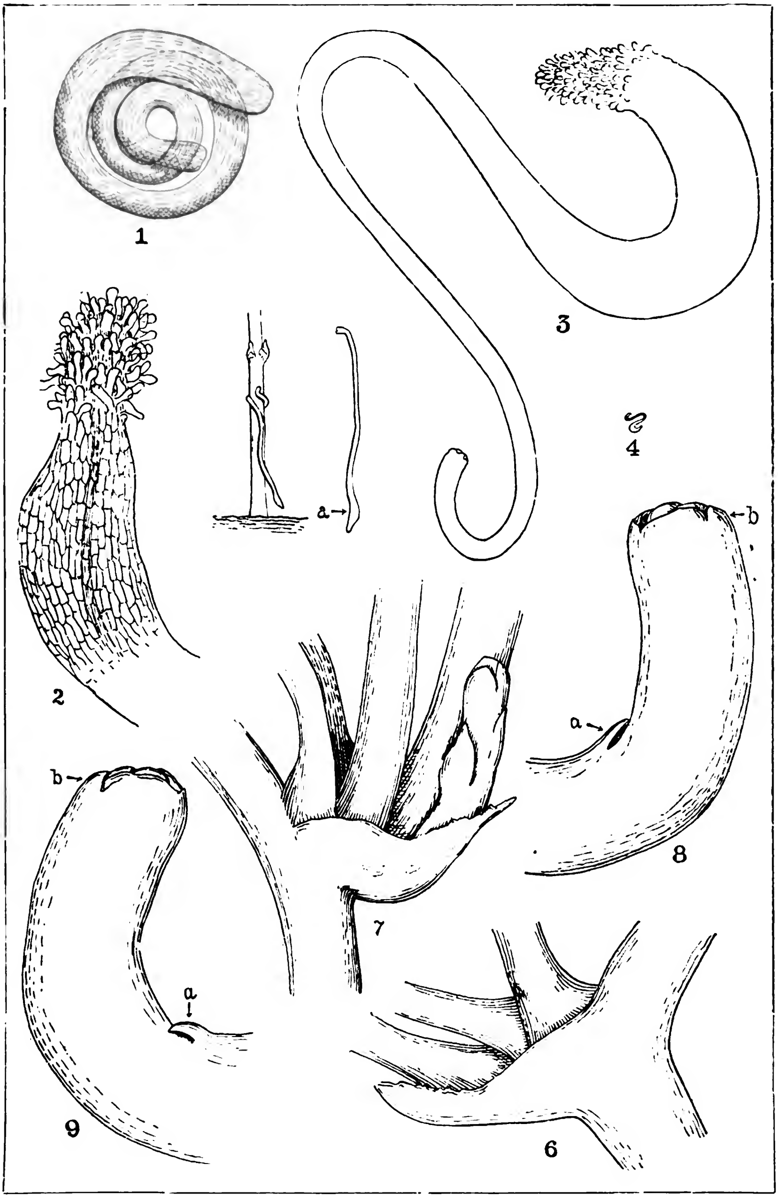
BLAKEA GUATEMALENSIS n. sp.



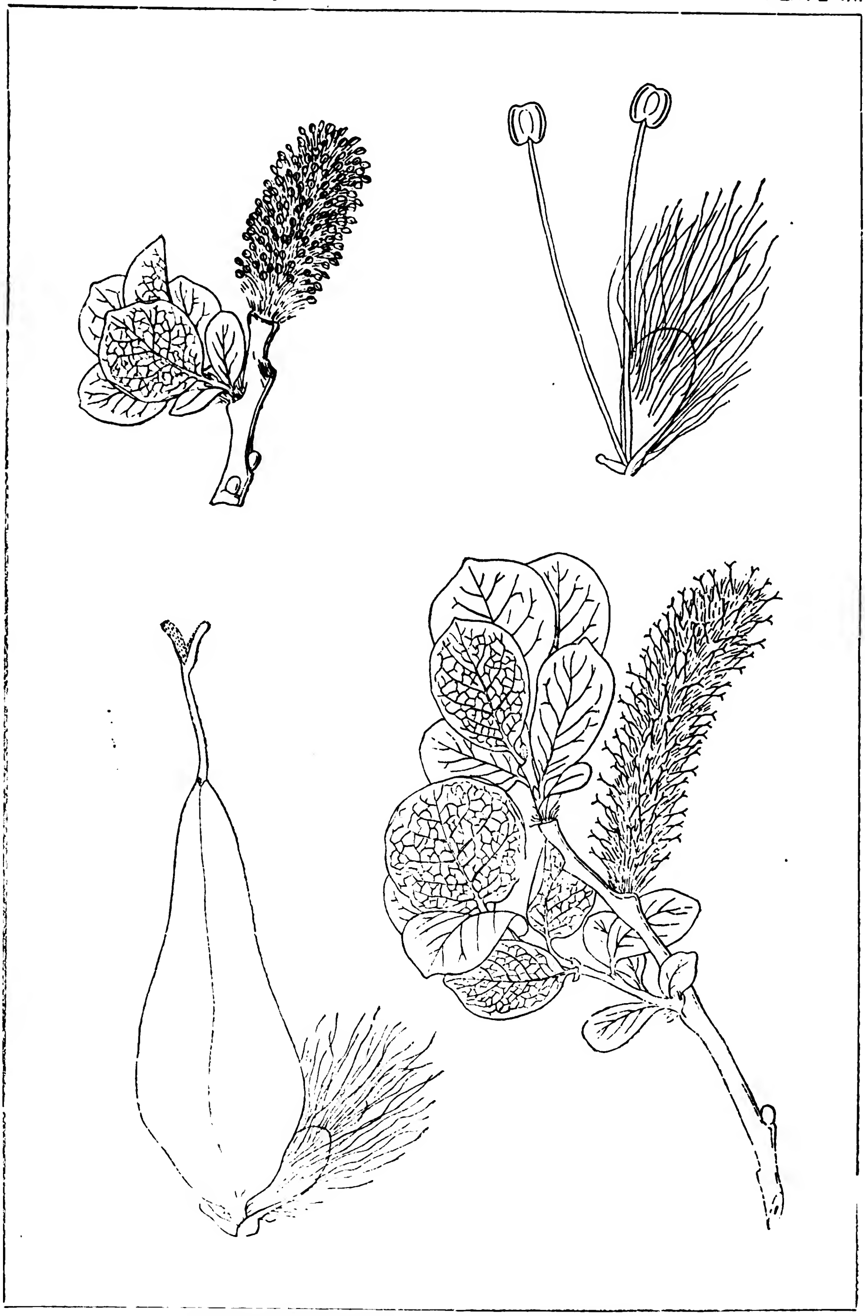
C. E. Faxon, del.

LOUTERIDIUM DONNELL-SMITHII, Watson.

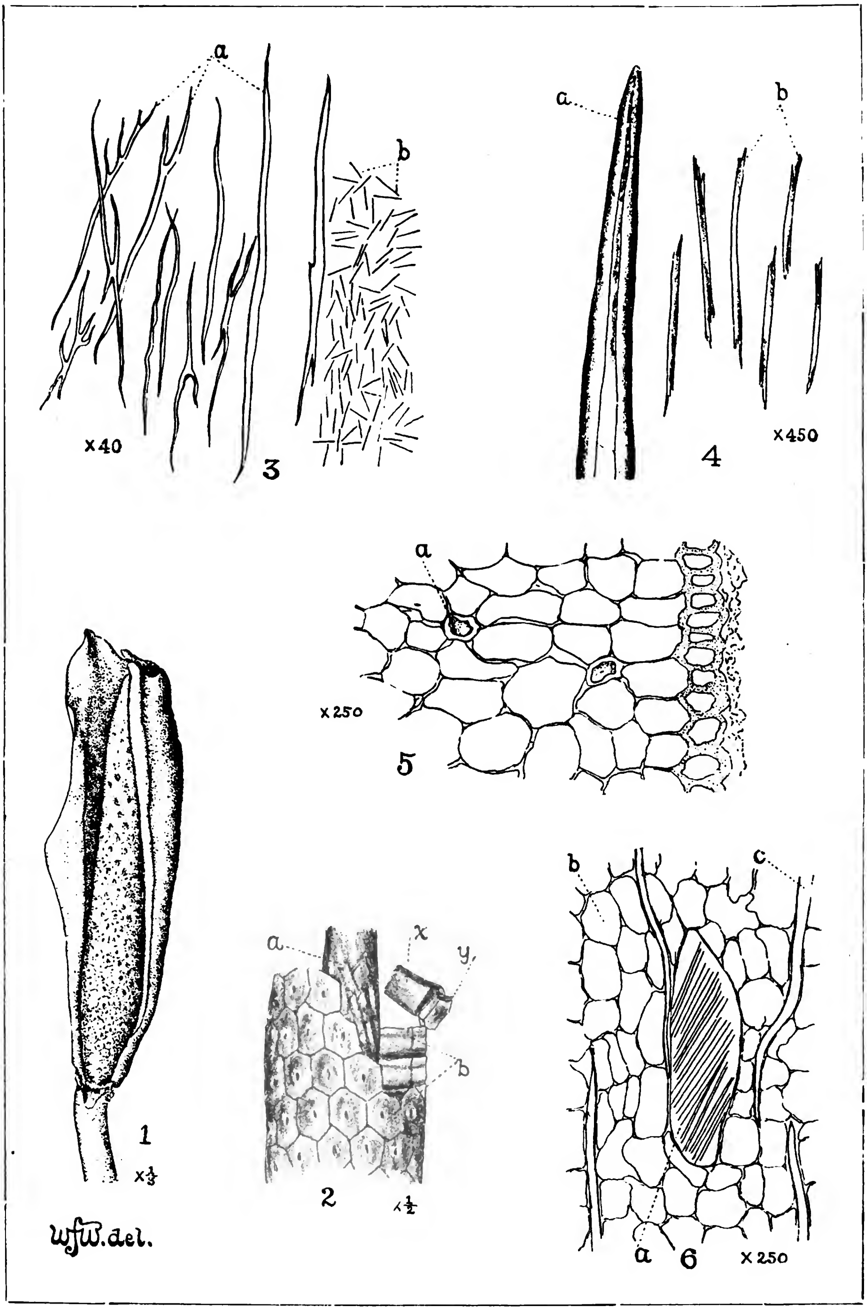
B. Meisel, Lith. Boston.



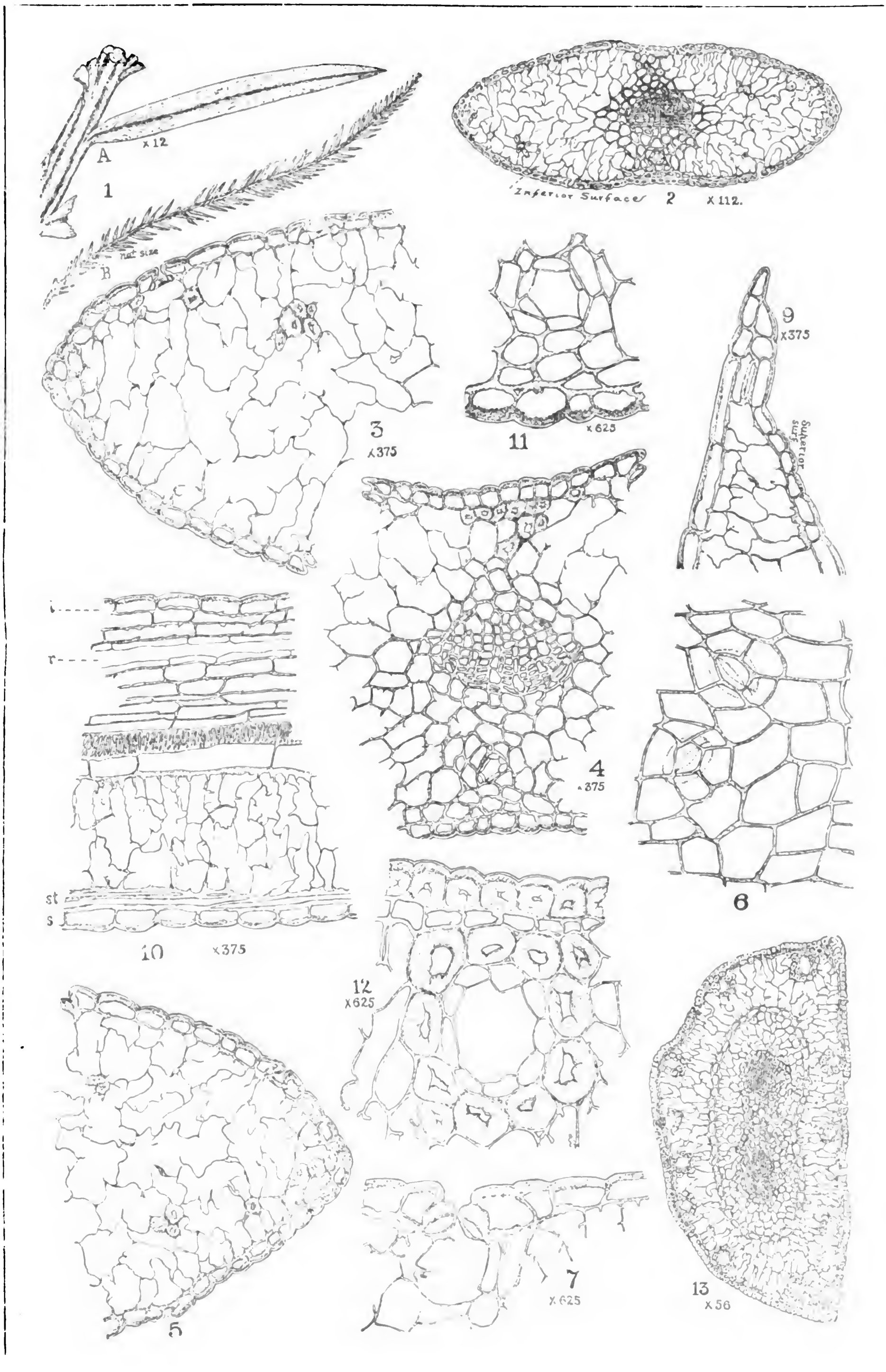
HOOKER on CUSCUTA GRONOVII.



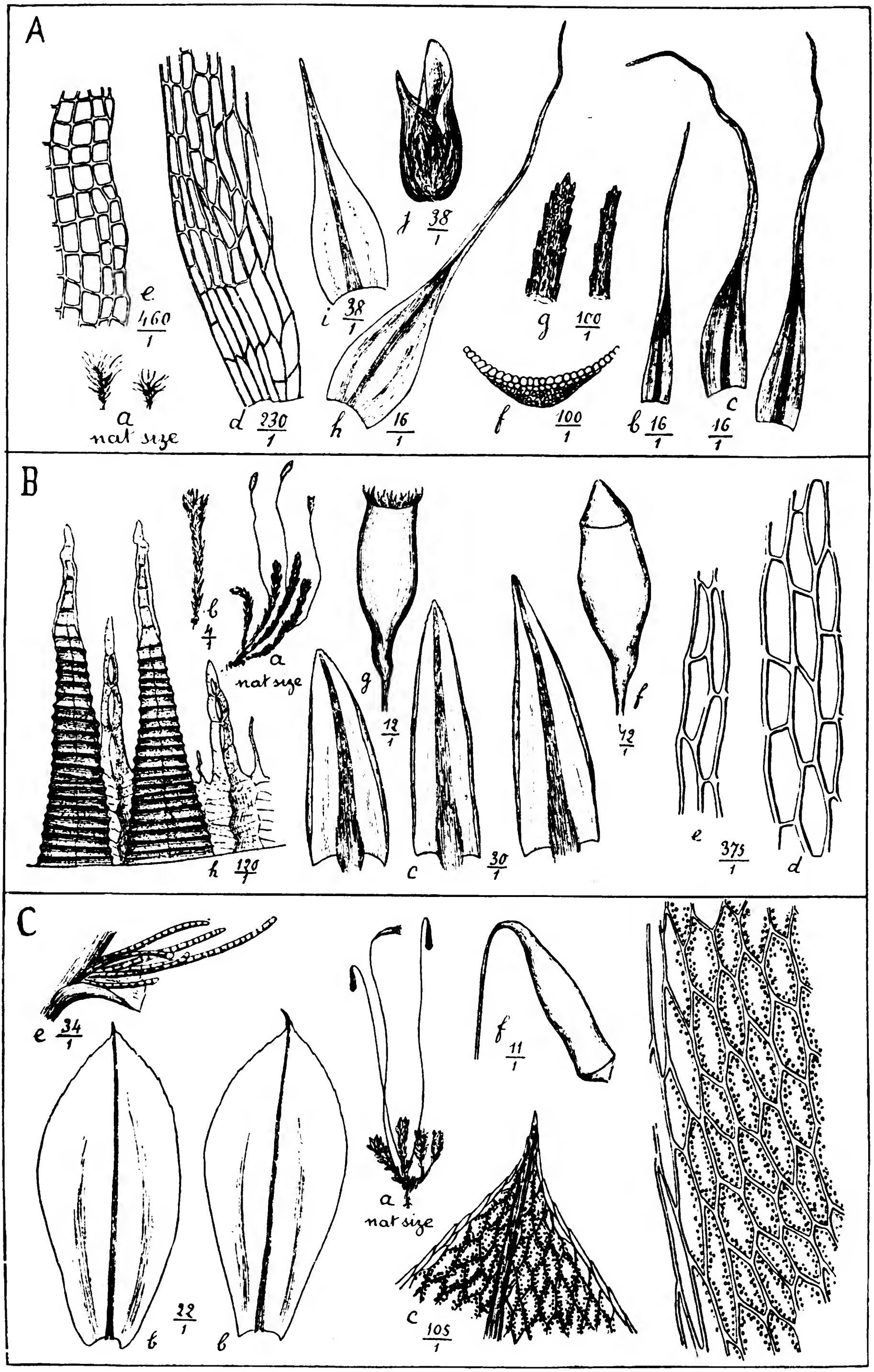
SALIX RICHARDSONII, var. MACOUNIANA BEBB.



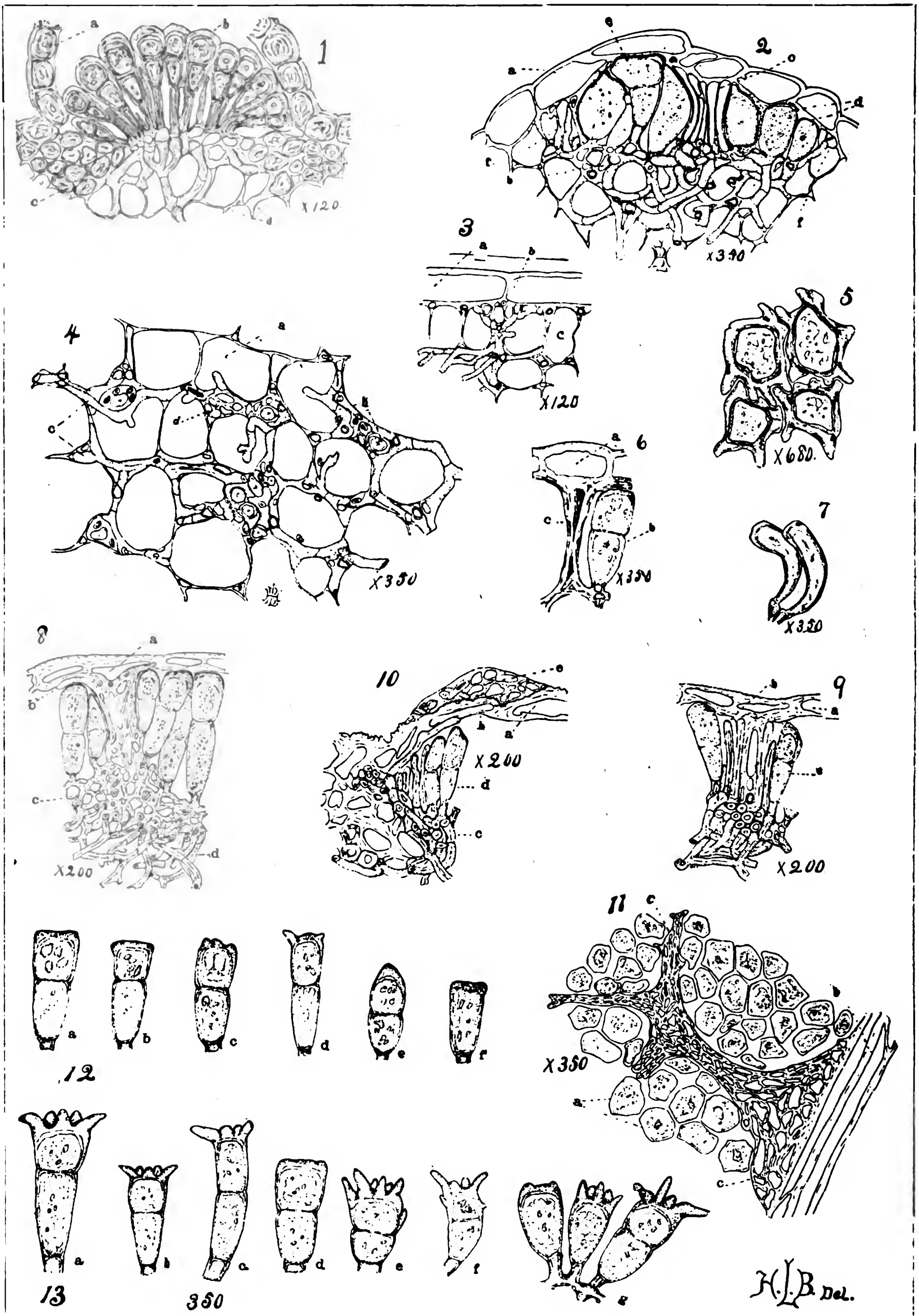
WINDLE on FRUIT OF MONSTERA.



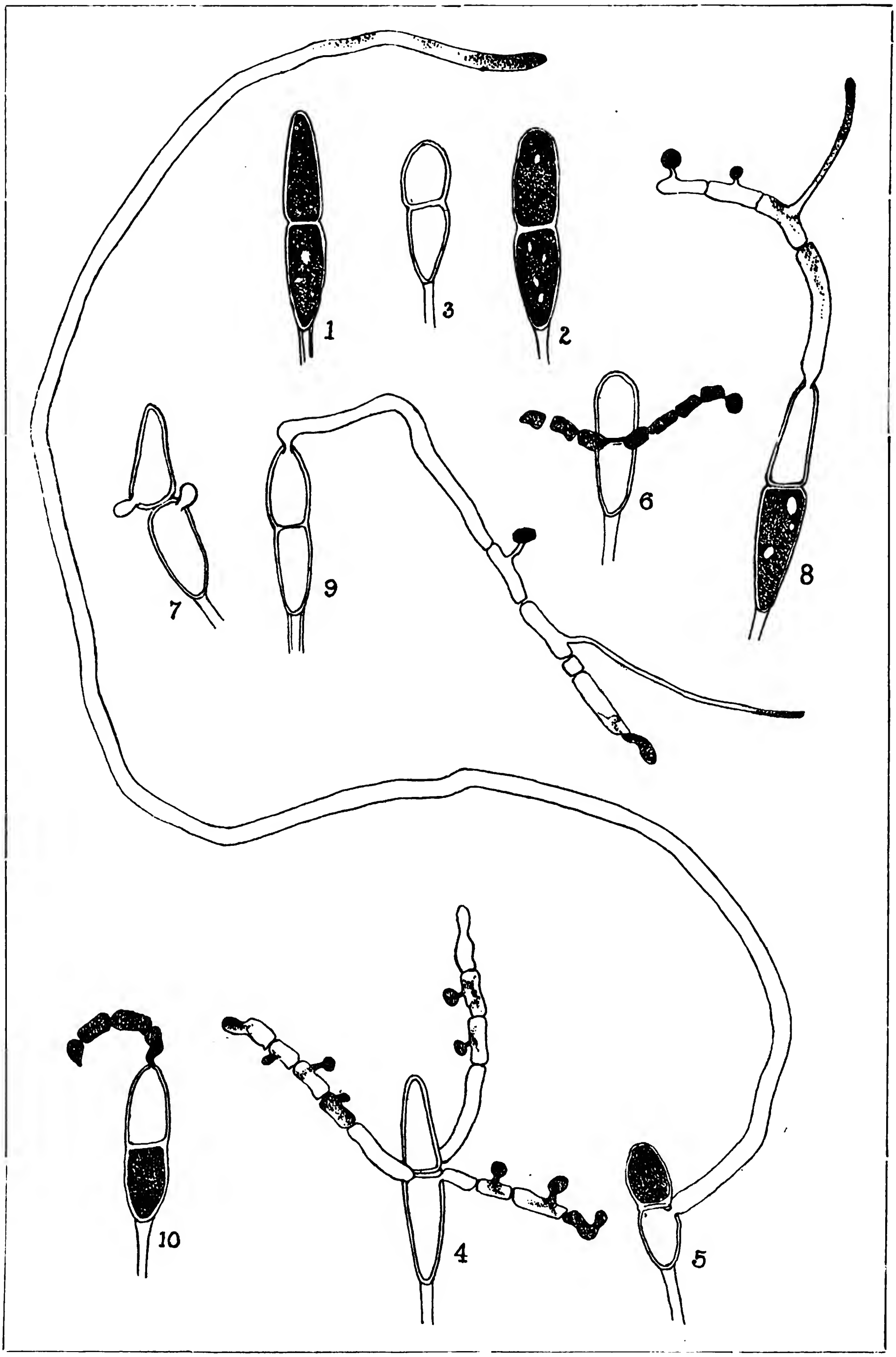
S. COULTER on LEAF OF TAXODIUM.



RENAULD AND CARDOT ON NORTH AMERICAN MOSSES.



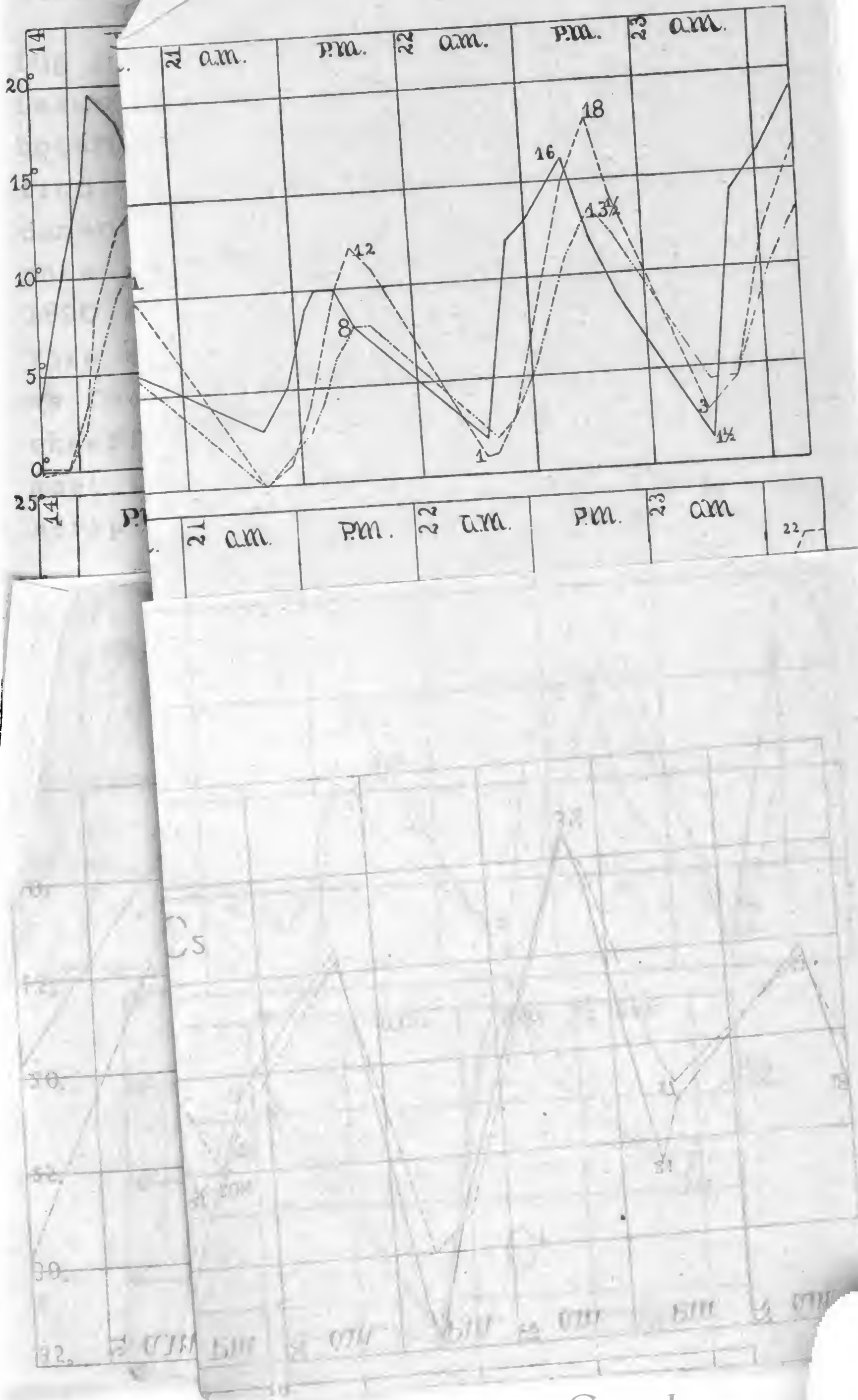
BOLLEY on SUB-EPIDERMAL RUSTS.

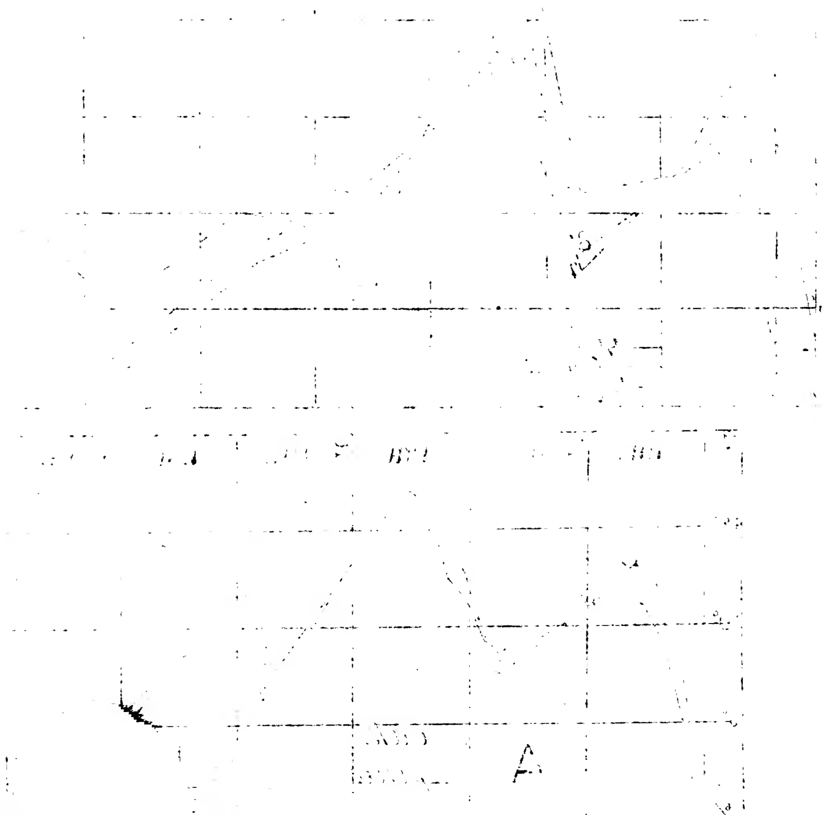


RICHARDS on GYMNOSPORANGIUM.

BOTANICA

PLATE XVIII.





IMPORTANT NOTICE.

There has been a great and increasing pressure upon the Botanical Gazette to issue fine plates. Much of the best botanical work demands adequate illustration. We are always ready to respond to demands that indicate progress, and propose to make the Botanical Gazette for 1890 superior to any preceding volume. This step, however, is a costly one, and we feel sure that American botanists will cheerfully aid us in taking it. We can meet this demand by increasing the subscription price to $2.50.

As this notice is somewhat late, we make the following concession: All old subscribers who renew their subscriptions before January 1, 1890, can obtain the Gazette for 1890 for $2.00. All connection with subscription agencies has been severed and the rate hereafter will be an invariable one to all subscribers.

The Botanical Gazette for 1890 -	$2.50
Old subscribers who renew before January 1 - - - -	2.00

EDITORS OF THE BOTANICAL GAZETTE.

Crawfordsville, Ind.,
December 1, 1889.

ANNOUNCEMENT

—OF THE—

BOTANICAL GAZETTE

FOR 1890.

The **prosperity** of the GAZETTE during the last year has suffered no check in any direction; on the contrary never in its history has it had more subscribers or better contributions. It is gratifying to the publishers, as it must be to all friends of the magazine, that it is enabled to so fully represent the character and indicate the extent of the increasing **botanical activity** of the country, a position which it hopes to merit and maintain.

The monthly issues still continue to **over-run twenty-four pages,** and are **illustrated** with cuts in the text, and an average of one or two plates, done in the best style of illustrative typographical art.

The list of contributors during 1889 shows the same array of **learned writers and investigators** as heretofore, with every indication of continuance for the coming year. The increasing number of **contributions from European botanists** is significant of the growing regard for Amerfcan botanical science abroad, as well as an indication of the GAZETTE'S standing.

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JOHN M. COULTER,
CHARLES R. BARNES,
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